# The Foundry Trade Journal

AND

## PATTERN-MAKER.

THE OFFICIAL ORGAN OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

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THE FOUNDRY TRADE JOURNAL,
165, Strand, London, W.C.

BRITISH FOUNDRYMEN'S ASSOCIATION.

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## NOTES AND COMMENTS.

### Buying Pig Iron by Analysis.

In a paper which he read before the Society of Arts recently, Mr. Robert Buchanan strongly advocated the use of analyses in ordinary foundry practice, as a safeguard against the considerable variations which occur in the cupola mixtures, and consequently in the resulting castings. He also, in the course of his remarks, somewhat disparaged the use of the fracture grading system which is universal in foundry plants; but while it cannot be disputed that working to analysis is certainly superior to any "rule-of-thumb" method, there are many considerations which, for the present at any rate, render it extremely difficult for every one to adopt the analysis system. There is first the difficulty of obtaining from the makers pig-iron of comparatively unvarying analysis, and this difficulty Mr. Buchanan himself acknowledges, though no doubt a good deal could be done by a united effort on the part of founders to insist on buying to analysis. Makers will only accede to the demand now, when the order is sufficiently large to influence them, but on the whole they fight shy of committing themselves to any definite product. There are, of course, certain irons which vary but little, and these are generally correspondingly more expensive. The average make of pig-iron, as most founders know, varies very considerably, and it is sure to do so, while the crude method of grading by fracture into Nos. 1, 2, 3, etc., still holds sway; and when it is considered how great an influence a little variation in one element will have on a casting, it becomes more than ever a question to be settled definitely.

Many foundrymen, doing a general class of work, experience a large demand for soft castings, as purchasers frequently do not really appreciate the value of a suitably hard article. The

demand, however, has to be met, and so the foundryman by experience and experiment produces a metal which first has the desired quality of softness, other considerations being left comparatively out of the question.

The application of scientific analysis would enable the full requirements of each class of work to be met, but only in the hands of a competent metallurgist would it prove of any use, and this is what the average foundryman is not. A growing tendency is remarked in the rising generation of foundrymen to take up the scientific side of their work in a serious and studious manner, and only by so doing shall we develop a race of men who will place founding in its proper status amongst the crafts.

The application of the analysis system to foundry work in general would savour somewhat of a revolution, but it would be for the better, and, moreover, it may be believed that we are evolving to such a state.

But when it is remembered that pig-iron makers would be committed perforce to a better and perhaps costlier style of work, it cannot be wondered that they postpone the day as long as possible. It is for the foundryman to take the matter up, and by making himself competent to apply the advantages to force the pig-iron maker to meet the requirements.

## The Szekely Process.

At the conclusion of Mr. Buchanan's paper, Dr. Szekely spoke briefly concerning his process. He stated that his object was to place before founders as a community a method of producing continuously castings which would not suffer shrinkage or chill, but would be machineable and marketable, and this without more consideration being given to mixtures than is at present given. He had evolved his system after 18 years' research and experiment, 12 years of which proved practically non-productive. Not until he finally discarded the traditional basis of foundry practice and stepped aside from the recognised scientific law, which always based its procedure on sand moulding, did he meet success. Progress on the old lines was hindered by two factors having to be considered, viz. :—The presence or production of various gases as a result of the sand mould coming into contact with the hot metal, and the fact that sand is a very slow conductor of heat. The difficulties met with in using the sand mould are many, not the least being contraction or unexpected expansion. With the iron mould these difficulties were avoided, as iron was a quick conductor, and made a stable mould, unlike the sand, which was soft.

## A Scheme for Pig-Iron Purchases by Analysis.

At a meeting of the Committee of the American Society for Testing Materials to consider standard specifications for cast-iron and finished castings, in view of the increasing employment of analysis as the basis of pig-iron purchases, it was thought best to provide specifications from which grading by fracture and the use of numbers to designate various grades of pig-iron should be eliminated. The subject was discussed informally. A scheme was proposed in which the six vowels were made use of, together with the initial letter of the name of each metalloid, to construct a code designating percentages of the various non-ferrous constituents of pig-iron. Since silicon and sulphur have the same initial letter, C was suggested as the designation for the former. The percentages of the different elements and the corresponding symbols under this scheme are given in the following :—

*Silicon.*

| Symbol. | Per cent. |
|---|---|
| Ca | 0.50 |
| Ce | 1.00 |
| Ci | 1.50 |
| Co | 2.00 |
| Cu | 2.50 |
| Cy | 3.00 |
| Allowable variation | 0.25 |

*Manganese.*

| Symbol. | Per cent. |
|---|---|
| Ma | 0.50 |
| Me | 0.75 |
| Mi | 1.00 |
| Mo | 1.25 |
| Mu | 1.50 |
| My | 1.75 and over. |
| Allowable variation | 0.125 |

*Sulphur.*

| Symbol. | Per cent. |
|---|---|
| Sa | 0.04 |
| Se | 0.05 |
| Si | 0.06 |
| So | 0.07 |
| Su | 0.08 |
| Sy | 0 09 |

Percentages are maxima.

*Phosphorus.*

| Symbol. | Per cent. |
|---|---|
| Pa | 0.25 |
| Pe | 0.50 |
| Pi | 0.75 |
| Po | 1.00 |
| Pu | 1.25 |
| Py | 1.50 and over. |
| Allowable variation | 0.125 |

In the case of silicon, with an allowable variation of 0.25 per cent., Ca would stand for a range in silicon content from 0.25 to 0.75 per cent. In the case of manganese the allowable variation suggested was 0.125, so that Ma would represent a range of 0.375 to 0.625 per cent. Similarly in phosphorus the suggested variation was 0.125 per cent. In the case of sulphur, as determined by the gravimetric method, the percentage specified is the maximum, and any excess of sulphur would result in rejection. It should be noted that there is no connection between the symbols employing the same vowel. Naturally, high silicon would be accompanied by low sulphur, and therefore Sa as the symbol of a sulphur content under 0.04 per cent. has no correspondence to Ca, which represents the lowest silicon content in the schedule.

### A Cost System.

We make no apology for the large amount of space given up in this issue to Mr. Weatherall's excellent paper on "Methods of Costing." Although he deals with a general system of costs, there is much in it that can be applied with advantage in foundry practice. We are too much accustomed to listen to American experts on this subject, or to accept the statements of makers of card index files and office furniture, who are interested parties. Mr. Weatherall makes a good part when he says that if a card is lost one of the most important links in the chain is gone, and as he points out a ledger is after all only a set of cards bound into a volume.

### An Association of Copper and Brass Manufacturers.

A suggestion which was put forward by Mr. W. H. A. Robertson, of Bedford, that a technical association should be formed for copper and brass manufacturers, has not taken long to be put into effect. At a meeting held in Manchester recently, under the presidency of Mr. W. H. Johnson, it was resolved to form an Institute, which should fulfil the same functions in relation to the copper and brass trades, as the Iron and Steel Institute does in respect of the iron and steel trades. There is at the present time no association which covers the ground which it is proposed to occupy The Iron and Steel Institute does not profess to touch anything outside of iron and steel, and the minerals and metals used in its manufacture.

There is one other society. Unfortunately, however, the British Foundrymen's Association has done practically nothing at all for those of its members who are occupied in founding metals other than iron, and consequently its membership is largely composed of those connected with iron foundries. Its papers and discussions have shown far too great a tendency to become of an academic character, and whereas it is a fact that a small percentage of the membership of the Iron and Steel Institute is interested in such discussions, it is very certain that the average foundry manager neither knows, or cares to know, the difference between pearlite, cementite, and other micro-constituents of iron and steel. It is a great pity that in this country the practical side of foundry is very largely neglected, except in the technical press. We are always pleased to receive practical papers, but they do not come forward in as great a quantity as we should like. Papers are forthcoming in large numbers from college professors, but it is only occasionally that the suggestions made in these papers can be applied by the practical man. What is required is that the practical men should come forward in greater numbers and offer the results of their experience. Where practical work on novel lines has been carried out, we are far too much disposed in this country to keep the results a profound secret, and while this continues to be the case, technical progress can never be as rapid as it is in the United States and Germany, where this practice does not exist to anything like the same extent.

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Mr. R. G. Thomson and Mr. A. Ramsay have established themselves in business as consulting, electrical, mechanical, and ventilating engineers, at Castle Chambers, 55, West Regent Street, Glasgow.

It is stated that the Metropolitan Amalgamated Railway Carriage and Wagon Company, of Birmingham, have offered to raise a battery of heavy artillery, with its full complement of six officers and 233 men, within their works, as well as to furnish the buildings required for drill and administrative purposes. The men cordially support the scheme, and it is thought that other large firms might follow a similar course.

## SMALL CONVERTERS FOR STEEL FOUNDRIES.

For some time past small converters on a modified Bessemer system have been largely used in Germany and Belgium. In England the Tropenas system has been used to some extent with success, but no process of the kind has been very largely adopted, although numerous processes have been brought forward, such as the Schwartz, used by the Roe Steel Castings Company, and the Gebauer-Zenzes, used by the Parker Foundry Company. Mr. L. Uckenbolt, of Charleroi, who has himself designed a converter of this kind, has pointed out that one objection urged against the small converter is that it does not become profitable unless a minimum charge of 10 tons is dealt with per diem. Against this he instances one foundry at Leipzig which does a good trade in small castings, which are sent even to Westphalia, though the capacity of the plant is less than the above figures. The Belgians have for some years been supplying Germany with axle bushes, dynamo casings, and other small castings, in competition with German iron founders working with open-hearth or crucible furnaces. Mr. Uckenbolt claims that his converter will work at least as cheaply as a 6-ton open-hearth furnace, under any conditions: in fact, with the former a daily output of 10 tons can be produced at the same cost per ton as it takes an output of 30 tons to equal in the case of the open-hearth furnace. Of course, the cost is lower, *pro rata*, when the number of charges is increased, but the minimum essential output in order to yield a profit is less than with the open-hearth furnace.

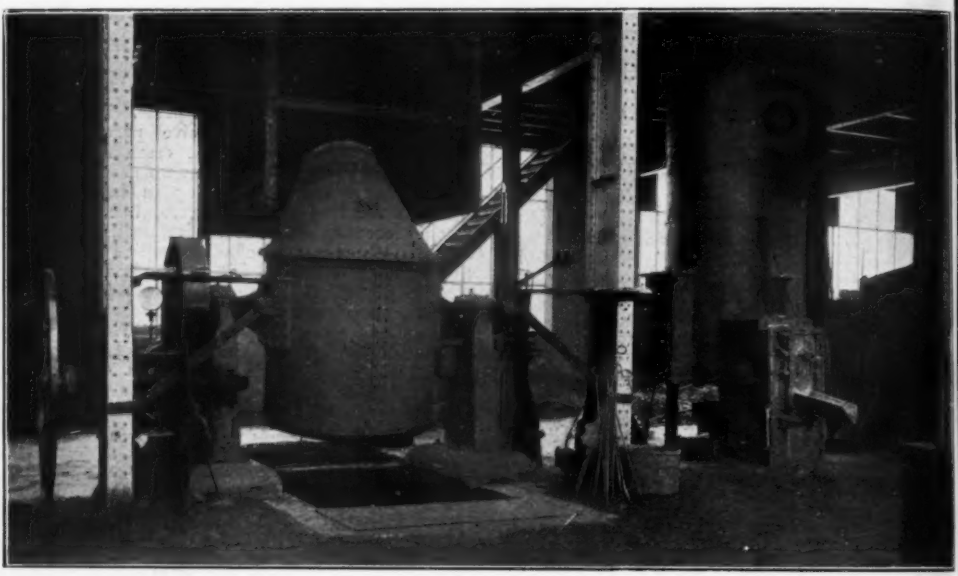

FIG. 1.—SMALL CONVERTER PLANT AT THE WORKS OF THE NORDDEUTSCHE MASCHINEN AND ARMATUREN FABRIK AT BREMEN.

Examples of the small converter type of foundry are shown in Figs. 1 and 2, which show two plants in Germany working with the Uckenbolt converter.

So far as the blast is concerned, some founders use a 150 to 300 h.p. engine, and 3,500 to 10,500 cubic feet of air, the pressures ranging from 7 to 40 lbs., whilst others again do with a 25 h.p. engine, and even one of 9 h.p. Struck with these differences, Mr. Uckenbolt has gone into the question of blast very carefully, and found that in the former case there was a very great deal of waste, the useful effect of the blast air being very low in proportion to the energy expended. He

also found that 1,400 cubic feet of air per minute is sufficient for a blowing period of 15 to 20 minutes in steel making with the small converter; and on this basis put up a small plant for the Norddeutsche Lloyd., which plant turned out very satisfactorily. A second plant, on the same lines, but with 2,100 cubic feet of air per minute, was erected for the F. Krupp Grusonwerk, at Buckau, and answered equally well. The main point, after all, is not so much the quantity of air supplied as the way in which it is utilised in the converter. This utilisation depends on the arrangement of the tuyeres, and several different systems have been proposed and used. In one the air is blown through the bottom of the converter and rises vertically through the bath; in another the tuyeres are mounted laterally below the surface of the metal; a third plan is to set them above the bath so as to blow in a direction parallel to the surface; a fourth, to blow down on the surface at a certain angle; and in others again the blast is directed vertically from above or below the surface, or through two sets of tuyeres at different levels above the bath and parallel to the surface.

Of these methods, the first-named is very wasteful, since the air rises in columns through the metal and only comes in contact with the same as it bursts through the superficial layer. Tests made on the products of combustion in the converter show that in such event only 4 per cent. of the 21 per cent. of oxygen present in the blast air is utilised. Of all the other systems the best results are furnished by the single layer of horizontal tuyeres above the surface of the bath, and by the tuyeres set aslant, so as to blow on to the surface of the metal at a certain angle. In the former, difficulties arise when the charge in the converter is too small or too large, the air in the former event escaping without coming into proper contact with the metal, whilst when the charge is too large there is risk of it flowing into and choking the tuyeres. These difficulties are obviated by Mr. Uckenbolt's method, the air being led through a tuyere of sufficient length to give it the desired direction, so

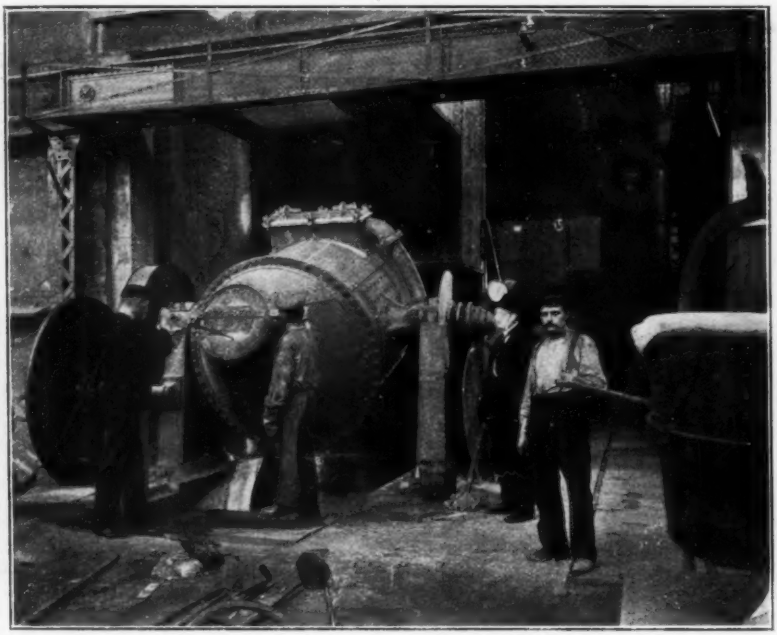

FIG. 2.—UCKENBOLT CONVERTER AT THE FRIED KRUPP GRUSONWERK, BUCKAU.

that it spreads over the surface of the bath like a fan. An essential point to success is to keep the tuyeres free from slag, since otherwise the air will be deflected and its influence diminished. By this system as much as 9 per cent. of the oxygen in the blast is utilised, as compared with 4 per cent. in the vertical blast.

until the full pressure has been reached, or the crust of oxides will no longer be forced away by the weak current of air, but keep growing thicker and prevent the air coming in contact with the underlying metal. To avoid this inconvenience, a valve is provided in the blast main, and the air is allowed to escape into the open until full pressure is reached.

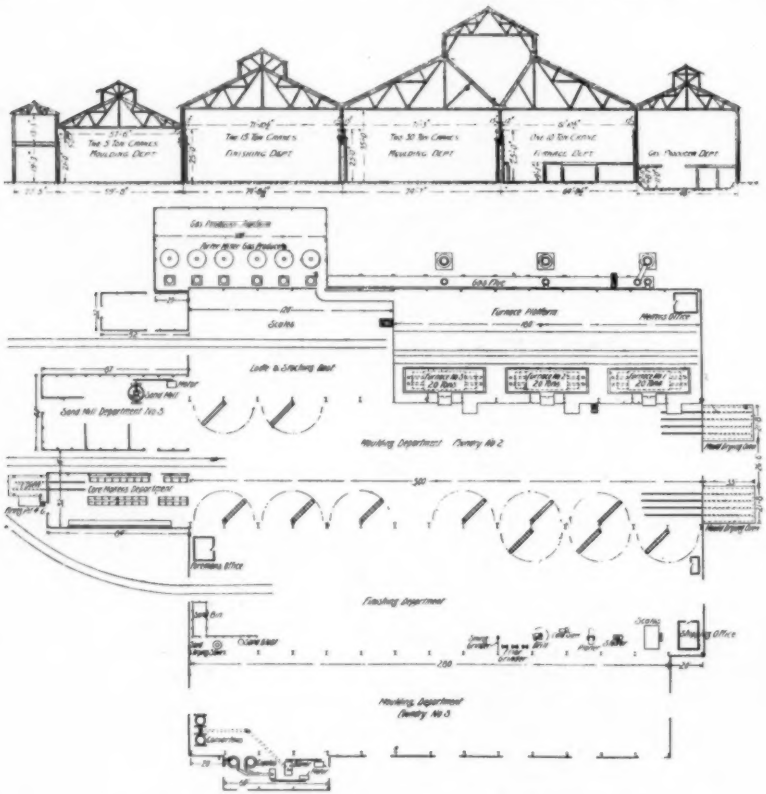


FIG. 3.—PLAN AND CROSS SECTION OF NEW STEEL PLANT.

FOUNDRY PLANT OF THE SCULLIN GALLAGHER IRON AND STEEL COMPANY.

Sufficient pressure must be kept up to blow aside the crust of oxides and slag that otherwise tend to accumulate; this pressure, however, is only a moderate one, the film of incrustation being thin, if the slag has been tapped before beginning to blow; in fact, a pressure of 4½ lbs. is sufficient. A point to be remembered in working this system is that the blast should not be turned on

With regard to the statement that it is more convenient for small converter work, to prepare the pig-iron in cupola furnaces, mounted on a higher level so that the fluid pig-iron can flow direct into the tilted converter; this is no doubt an advantage in the case of large converters, but Mr. Uckenbolt prefers to use ladles and have the cupola furnace on the ground level, since in that case it can

be used for making grey castings, and for other purposes.

Respecting the possibility of producing high-class casting metal of increased strength, by the small converter process, Mr. Uckenbolt regards the operation as not too expensive to practice; but his experiments with mixing pig-iron and converter steel gave irregular results, and he found that the product could be obtained more cheaply and uniformly in the cupola furnace. A small converter with a single tuyere, 1½ in. in diameter, was in use in a Swedish iron works for some years, for converting pig-iron into tool steel ingots, but was abandoned.

Some founders are adopting both processes. An example of this practice is the Scullin-Gallagher Iron and Steel Company, of St. Louis, which claims to have the largest individual plant for making steel castings in the United States. The number of men employed day and night is 2,000, and the capacity is 250 tons of castings in 24 hours. The Company has, for some time, made a speciality of cast steel bolsters for railway wagons. The total output in 1906 was about 40,000 tons.*

The original foundry No. 1 was built in 1899, and since then the works have grown so as to include the large lay-out which is shown on the accompanying plan. In 1905 the No. 2 foundry was added, and in 1906 the No. 3 plant was erected. The older plant No. 1 is used particularly for the manufacture of cast steel bolsters and couplers and consists of a furnace room 68 by 400 ft., having five 20-ton basic open-hearth furnaces, which

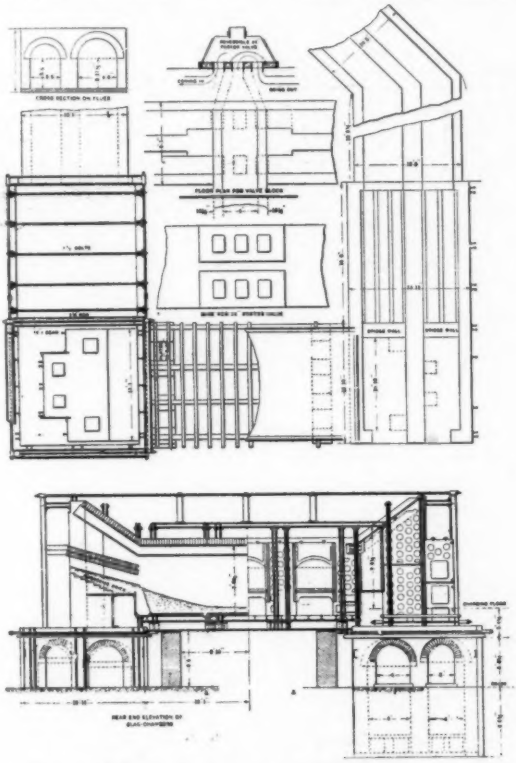

FIG. 4.—DETAILS OF 20-TON SIEMENS FURNACES; SCULLIN-GALLAGHER CO.

FOUNDRY PLANT OF THE SCULLIN-GALLAGHER IRON AND STEEL COMPANY.

* "Railway Age."

are served with a Wellman, Seaver & Head charging machine and a 10-ton overhead electric travelling crane. The gas house is 50 by 130 ft., and has ten Duff gas producers. The moulding-room is 75 by 500 ft., and has three 30-ton overhead electric double trolley travelling cranes, and eighteen 5-ton pneumatic jib cranes. This department is equipped with the most modern types of boilers, to which will soon be added 400 h.p.

West of No. 1 foundry is the machine shop, 50 by 100 ft., and to the south is a pattern shop 25 by 100 ft.; also two large pattern storage sheds each 60 by 100 ft.

The new foundry No. 2 is practically a duplication of No. 1, and is used for the manufacture of miscellaneous steel

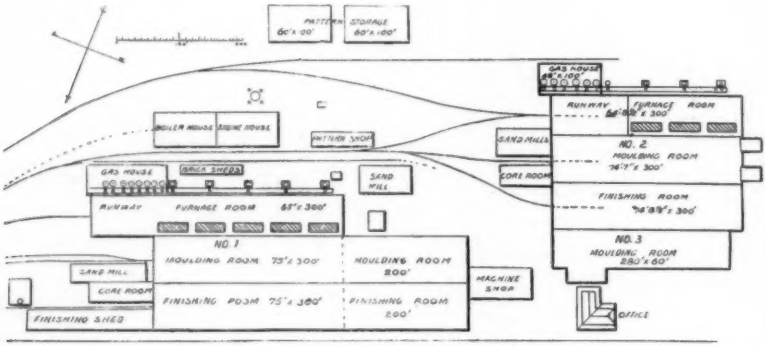


FIG. 5.—GENERAL PLAN OF FOUNDRY.

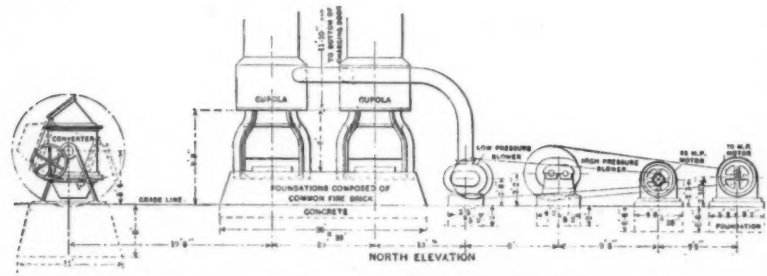


FIG. 6.—CUPOLA AND CONVERTERS IN SMALL CASTINGS DEPARTMENT IN FOUNDRY NO. 3.

FOUNDRY PLANT OF THE SCULLIN-GALLAGHER IRON AND STEEL COMPANY.

moulding machines and hoisting arrangements which give it a moulding capacity equal to the large furnace capacity. The chipping-room directly adjoining in the same covered space is 75 by 500 ft., equipped with two 15-ton overhead electric travelling cranes and hoisting machinery necessary to handle castings up to 80,000 lbs. This department is equipped with motor-driven lathes, planers, and emery wheels. Directly south of No. 1 foundry is the power house, which contains 800 h.p. of castings. The furnace room is 65 by 300 ft., and has three 20-ton basic open-hearth furnaces, a Morgan Company electric charging machine, and a 10-ton overhead electric travelling crane. The gas house is 50 by 100 ft., equipped with six Forter-Miller producers. The moulding room is 75 by 300 ft., and has some 30-ton overhead electric double trolley travelling cranes and fourteen 5-ton pneumatic jib cranes. The core department and drying ovens are in separate wings extending longitudinally from the

main building, leaving the entire moulding floor clear. The adjoining chipping room is 75 by 300 ft., with two 15-ton overhead electric double trolley travelling cranes, and it is equipped with improved sand-blast cleaning machines, emery grinders, cold saws, slotters, shapers, planers, and other necessary machine tools for trimming steel castings. This new foundry No. 2 is shown in the ground plan and cross-section in the illustrations. The height of the two main buildings is 35 ft. from floor to lower side of roof truss and 25 ft. from floor to top of rail on the crane runway. The foundry buildings are all built entirely of steel columns and structural steel roof, with sides covered with corrugated steel.

The latest building to be added to the plant is the one marked No. 3 on the north side of No. 2 foundry. This building is 280 by 60 ft., with a lean-to 20 by 60 ft., in which are located the blowers and cupolas for the Tropenas process. There are two 3-ton converters which can turn out 12 heats per day, or 36 tons.

While the steel furnaces have sometimes been operated by coal-gas, oil fuel is preferred, and substantial storage tanks have been built, having capacity of 10,000 barrels of fuel oil.

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## CORRESPONDENCE.

### INSTITUTION OF COPPER AND BRASS MANUFACTURERS.

*To the Editor of the* FOUNDRY TRADE JOURNAL.

SIR,—A meeting of copper and brass manufacturers, engineers, and others, was held in Manchester on February 13. Mr. W. H. Johnson (Messrs. Richard Johnson, Clapham & Morris, Limited, Manchester) was elected to the chair.

It was unanimously resolved to form a Copper and Brass Institute. The objects of the Institute are similar to those of the well-known Iron and Steel Institute, viz. :—(1) To afford a means of communication between members of the trades in question, bearing upon their respective manufactures, excluding all questions connected with wages and trade regulation. (2) To arrange periodical meetings for the purpose of discussing practical and scientific subjects relating to the manufacture, working-up, and use of the non-ferrous metals.

It is not the intention of the founders to limit the Institute to the copper and brass trades, but to include all those connected with the commercially important non-ferrous metals and their alloys, such as lead, zinc, tin, aluminium, nickel, silver, gold, platinum, etc., etc., and their alloys.

In order to obtain a much wider and fuller discussion than was possible at the preliminary meeting, and to define the constitution and method of procedure of the Institute, it is proposed to hold a meeting in the Midland Hotel, Manchester, on Tuesday, March 10, at 4 p.m., to which all those interested are most cordially invited. This letter is the only public summons to the meeting that will be issued.

All who hope to attend the meeting, or take an interest in the formation of the proposed Institute, are requested to send their names to any of the following :—

WILLIAM H. JOHNSON,
c/o Rd. Johnson, Clapham & Morris, Limited, Manchester.

H. C. H. CARPENTER,
Professor of Metallurgy, The University, Manchester.

G. G. POPPLETON,
c/o The Wholesale Traders' Association for the Hardware and Metal Industries, Birmingham.

Manchester,
February 17, 1908.

### A SIMPLE BUT EFFICIENT PATTERN-MAKERS' HOME-MADE GAUGE.

*To the Editor of the* FOUNDRY TRADE JOURNAL.

SIR,—With reference to the article under the above caption in your journal for February, 1908, an error occurs. The article reads :—A is a piece of steel wire $\frac{12}{16}$ in. by 12 in. long. It should read $\frac{3}{16}$ in., not $\frac{12}{16}$ in.

Yours, etc.

T. ALDCROFT CROSBY.

—o—

THERE is no foundation for the rumour that the Great Northern Railway Company (Ireland) intend to remove their locomotive works from Dundalk to Belfast. Dundalk is the centre, and is the most convenient place on the company's line, and they have equipped these works with all the most improved machinery.

C

## DIRECT CASTINGS FROM BLAST FURNACE METAL.*

By John J. Porter.

The subject of direct castings, or of castings made direct from blast furnace metal, is one which has for many years appealed to me as being worthy of greater attention than has yet been given it. The economies which could result from a successful application of this process are so evident and so important as to excite surprise that there is at least not more literature and general interest on the subject.

### Blast Furnace Possibilities.

It has also occurred to me that the recent progress made in the use of foundry alloys should have an important bearing on the subject and should possibly afford a way out of certain difficulties which have up till now proved insuperable. It is my hope that the following discussion of the problems and possibilities of direct casting may awaken some interest and draw out discussion on the subject, and in that way at least prove of some value to the metallurgical world.

Now the making of castings direct from blast furnace metal has both its advantages and its disadvantages; and, moreover, it seems possible that some of the objections urged against it might be readily overcome if the matter were gone into seriously. I will, therefore, take up the subject under these heads, and will first classify and discuss the advantages. As I see them these advantages are, broadly, the reduction of cost of castings, and an improvement in the quality of the metal.

### Cost of Castings.

The reduction of cost at least can hardly be disputed. In the first place we do away with considerable labour at the furnace end of the process, this labour being that necessary to mould down the pig beds, carry out and break the pigs and load them on the cars. The freight on the iron is next saved, and finally, at the foundry end, we save the cost of unloading the pig and coke, of handling them to the cupola, of all cupola labour, and of the coke used in the cupola.

The total of this saving will, of course, vary greatly according to the skill of the management, and the price paid for labour and coke at each particular time and place. A rough estimate of this saving may, however, be of interest, and an average taken from a number of cost sheets in my possession runs about as follows:—

| Saving in. | Per ton of iron. |
|---|---|
| Furnace labour ... ... ... ... | 0 7½ |
| Handling iron and coke at foundry ... | 0 10 |
| Cupola coke ... ... ... ... ... | 4 2 |
| Total ... ... ... ... ... | 5 7½ |

### Interest and Depreciation.

In addition we save the interest and depreciation on cupola equipment, but to offset this we will have to provide a casting machine to cast into pigs the "Sunday metal," as well as occasional casts of "off" and unsaleable metal. For our purposes we may consider these as equal, although an exact estimate would probably show an additional saving to the credit of the direct casting method. Freight is, of course, omitted in any general estimate, since in many cases at least the saving in freight on iron would be balanced by additional freight on the raw materials of iron-making.

### Losses of Iron.

One further source of saving should be noted, that is, the decreased loss of iron in scrap and in cupola slag. Although I have made no attempt to determine it quantitatively, I believe that this item would be of considerable importance.

### Improving the Quality.

Now, as to the improvement in the quality of the iron. This is evident, since in remelting iron invariably takes up sulphur and becomes harder and often weaker. In addition oxygen is frequently absorbed, greatly weakening the metal. It is a matter of common knowledge among furnacemen that castings of a given softness can be made with a much lower percentage of silicon in the case of direct metal than in the case of cupola metal, and also that for a given softness the direct metal casting is commonly the stronger; experience, therefore, bearing out the theory.

### The Furnace Output.

The disadvantages will next claim our attention, and of these I should place first the uniformly great output of the furnace. While it is true that there are still many furnaces in the country with outputs of 120 tons per day or less, still they are uneconomical, and no furnaces are at present built with a nominal capacity of less than 200 tons per day.

* Read at a meeting of the Associated Foundry Foremen of Cincinnatti, Ohio.

There are but few foundries that can handle 200 tons of iron in a day, and, furthermore, this output is practically uniform. At least it will vary between narrow limits only, and will be beyond the control of the officers of the company. This means either that the foundry must run full capacity all of the time without regard to the state of the market or of the order books, or else that the furnace shall, during such times, cast part of its product into pig-iron, and shall therefore enter the market as a seller of pig, presumably at the time of lowest prices.

### Furnace Shutdowns.

Again the fact that the furnace must occasionally shut down for repairs must be taken into account. True, with a well-managed furnace, this need only occur once in every two or three years, but when it does occur it means the shutting off of the source of supply for the foundry for a period of one or two months, involving, of course, an expense due to interest and depreciation of a lot of expensive equipment during the time. By piling pig-iron before the closing down of the furnace it is, of course, possible to run the foundry in the regular manner, but this involves the possession of cupola equipment, the ability to dispense with which was one of our chief advantages.

### Continuous Operation.

Another disadvantage which will occur to some is the fact that the blast furnace metal is produced at equal intervals throughout the day, generally being tapped every six or every four hours according to output. This means that there must be radical changes in the management of the foundry, several pouring periods taking the place of one, and preferably the foundry would be run continuously in day and night shifts.

Other disadvantages more technical in their nature arise from the difficulty of exactly regulating the quality of the metal coming from the blast furnace, as well as from the occasional falling off in quality, and the frequent presence of "kish" or segregated graphite. These difficulties all arise from the fact that blast furnace management is not as yet an exact science. Our limited knowledge is not yet sufficient to prevent the furnace from occasionally going wrong, or to enable us to hold the composition of the metal at any exact point for a very considerable length of time. These objections are, of course, very serious, and would perhaps prove insuperable, were not means at hand for overcoming them.

### Foundry Co-operation.

Next to be considered are the means for overcoming these difficulties, the first of which is the great output of our blast furnace. This, I take it, is best settled by a combination or co-operation of foundries taking metal from one furnace. A group of four or five moderately large foundries could easily consume the output of a furnace large enough to run economically, and might be arranged in a group, or they might be rather widely separated, and having only good railway connections with the furnace.

Cast iron as it comes from the blast furnace is considerably superheated and large ladles can therefore be kept for some time before it loses its fluidity. At many steel plants the furnaces are quite widely separated, and the iron is in some cases hauled several miles, reaching its destination in a perfectly fluid and satisfactory condition. A satisfactory system for distributing the metal and arranging its composition to suit the average needs of all the foundries would, of course, be necessary, but should not be very difficult to devise.

### Disposal of Excess Iron.

The fact that the furnace sends to the foundries a uniform daily stipend of iron without regard to the condition of order books, is a more serious matter. Probably this could be best taken care of by putting the excess iron through the casting machine and selling it in the open market. A full discussion of this point would be commercial rather than technical, and hence beyond the province of this paper.

The pouring of the iron at intervals through the 24 hours, corresponding to the tapping periods of the blast furnace, can be dodged if necessary or desirable by the use of a mixer such as is used in steel plants. This would act as a storage reservoir, holding several hundred tons of metal always in the molten condition. The heat is kept up by the periodical addition of fresh superheated metal from the blast furnace, and by the burning of a small quantity of gas over the surface of the metal in the mixer; the quantity of gas required here being so small as to be almost negligible. Using this, the pouring periods of the foundry could be arranged without regard to the furnace, except that it would probably be necessary to pour more than once a day, and it is likely that two 8, 9 or 10-hour shifts would be found desirable.

### Use of the Mixer.

The use of the mixer also offers a means of correcting the non-uniformity of blast furnace metal, since a number of casts being mixed here have their composition averaged up. Again, the use of the mixer is advantageous in that it improves the quality of the metal. The holding of the metal for a long time in the molten condition permits of the perfect separation of slag and insoluble oxides. Also much sulphur is eliminated by oxidation at the surface of the metal, while if a small amount of ferro-manganese be added the sulphur is almost completely removed from the metal. The mixer would also afford an admirable opportunity to adjust the composition and improve the quality of the iron by the addition of appropriate foundry alloys, ferro-silicon, for example, to secure the desired softness and ferro-titanium to purify and strengthen the iron. The iron here being at a high temperature and remaining for a long time in the molten condition there would be none of the usual troubles in securing thorough solution and perfect distribution of the alloy. In fact, the possibility of improving the quality of the metal in this way I would consider a very important advantage of the use of direct metal.

### Kish and its Elimination.

The presence of kish in direct metal is the last and perhaps the most serious of the difficulties which we shall discuss. Insufficient data exist at present to warrant any statement as to the best method for eliminating this substance, but there is no doubt but that it can be overcome. We know in the first place that kish does not appear except in high silicon iron. Direct metal being so much softer than cupola metal a high silicon iron would not usually be required. This would also reduce the fuel consumption of the blast furnace. Again, additions of preheated steel scrap to the metal in the mixer will reduce the carbon, do away with kish and also strengthen the metal. Finally, reasoning from theoretical grounds, it is quite probable that a soft iron free from kish could be obtained by the use of small quantities of aluminium.

### The Furnace Equipment.

Before leaving the question of quality of metal the management of the blast furnace should be considered. The average furnace is run more for tonnage than for quality, but in this case it would pay to give greater attention to quality, or at least to uniformity of quality, and a great improvement in this respect over the customary results could undoubtedly be realised. To accomplish this end a moderate sized furnace would be desirable as being more readily controlled. Rotary filling apparatus to prevent scaffolding would be essential, and a Gayley dry blast apparatus would greatly assist in the attainment of a uniform product. In passing it might be mentioned that by the use of gas engines a large excess of power could be obtained from the furnace, sufficient probably for the requirements of all the foundries depending upon it.

### Plant and Operation.

To summarise, I would suggest the following outline of plant and operation as best adapted for direct casting:—

A small furnace, equipped and managed primarily for quality and uniformity of product, about 175 tons per day.

Grouped about this furnace some four or five foundries with combined capacity of 175 to 200 tons per day. These foundries making a regular line of castings, preferably medium to heavy castings, and taking their iron and power from the blast furnace.

The iron from the furnace to go first to the mixer, which acts as a storage reservoir and where its composition is adjusted to a standard by the addition of suitable ferro-alloys, the metal also being thus purified and strengthened. From the mixer the iron to be drawn off as needed and taken to the foundries to be poured into castings.

### Net Advantages.

The net advantages of this operation would seem to be as follows:—

Saving of something over a dollar per ton in cost of iron.

Much better quality of iron and strength of castings.

Saving of iron ordinarily lost as cupola scrap.

Free power from the blast furnace.

While the chief and more insuperable disadvantages would seem to be:—

Non-elasticity of output of foundries in accordance with market.

Necessity of shutting down foundries or of melting pig during repairs of furnace.

Difficulty in quickly changing character of metal as required by some classes of work.

Possible presence of kish in some cases.

In conclusion, I wish to invite frank criticism and comment on this paper, and in particular would like to learn if I have overlooked any important reasons why such a combination as I have outlined should not be decidedly successful.

## ENGINE COSTS.*

By H. Weatherall.

The subject of engine costs in detail has generally, in engineering accountancy circles, been considered rather a delicate subject to deal with. It is true, volumes and articles galore have been written on

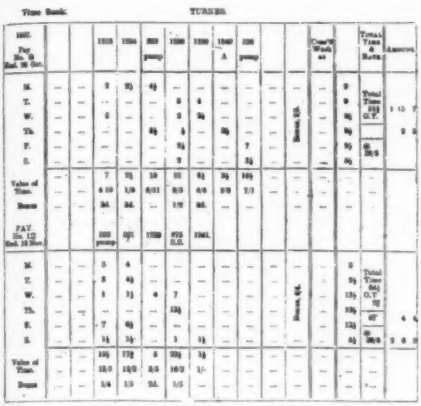

Fig. 1.

the subject of costs, but I have often expressed my surprise at the paucity of the knowledge given, or the few hints that I have been able to pick up and utilise. In saying this I am not unmindful of the fact that I have been with one firm nearly forty years, and that therefore my knowledge and experience of various systems of costs may be limited. I propose to go down to the bed rock of costs, namely, the workmen's time board or time sheet, and gradually work up to the finished article of engine costs. In most of our departments we still retain the time board. In our turbine department we have adopted the time sheet, so that we have had experience of both time boards and time sheets, but so far we have not adopted any of the card systems or time recorders except for the commercial office and drawing office, and foremen, whose incoming and outgoing are recorded by two of "Dey's" time recorders; and whilst I am not prepared to condemn the time recorder for costing purposes, I cannot say that for a large concern with a number and variety of specialities, the time board or time sheet is very far behind the times. I am still a believer in books as distinguished from cards for a permanent record. I emphasise a "permanent record." You lose a card and perhaps you have lost one of the most important links in your chain. However, I am not here to run down cards; they have their uses, and, in fact, the most important members of my staff have boxes of cards and are encouraged to use them for making notes and records, and for this they are extremely useful, but for permanent records give me a book.

And, after all, what is a book? It is simply a few thin cards or sheets of paper covered to keep them clean, and the cards or sheets fastened together so that they

3

3s. 6d. per week, or 79d. per hour.

¼ hr., 0d. ¼ hr., 0d. ¼ hr., 1d.

| Hrs. | Amount. | Hrs. | Amount. | Hrs. | Amount. | Hrs. | Amount. |
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| | £ s. d. | | £ s. d. | | £ s. d. | | £ s. d. |
| 1 | 1 | 31 | 2 0 | 61 | 4 0 | 91 | 6 0 |
| 2 | 2 | 32 | 2 1 | 62 | 4 1 | 92 | 6 1 |
| 3 | 2 | 33 | 2 2 | 63 | 4 2 | 93 | 6 1 |
| 4 | 3 | 34 | 2 3 | 64 | 4 3 | 94 | 6 2 |
| 5 | 4 | 35 | 2 4 | 65 | 4 3 | 95 | 6 3 |
| 6 | 5 | 36 | 2 4 | 66 | 4 4 | 96 | 6 4 |
| 7 | 6 | 37 | 2 5 | 67 | 4 5 | 97 | 6 5 |
| 8 | 6 | 38 | 2 6 | 68 | 4 6 | 98 | 6 5 |
| 9 | 7 | 39 | 2 7 | 69 | 4 6 | 99 | 6 6 |
| 10 | 8 | 40 | 2 8 | 70 | 4 7 | 100 | 6 7 |
| 11 | 9 | 41 | 2 8 | 71 | 4 8 | 101 | 6 8 |
| 12 | 10 | 42 | 2 9 | 72 | 4 9 | 102 | 6 9 |
| 13 | 10 | 43 | 2 10 | 73 | 4 10 | 103 | 6 9 |
| 14 | 11 | 44 | 2 11 | 74 | 4 10 | 104 | 6 10 |
| 15 | 1 0 | 45 | 2 11 | 75 | 4 11 | 105 | 6 11 |
| 16 | 1 1 | 46 | 3 0 | 76 | 5 0 | 106 | 7 0 |
| 17 | 1 1 | 47 | 3 1 | 77 | 5 1 | 107 | 7 0 |
| 18 | 1 2 | 48 | 3 2 | 78 | 5 2 | 108 | 7 1 |
| 19 | 1 3 | 49 | 3 2 | 79 | 5 2 | 109 | 7 2 |
| 20 | 1 4 | 50 | 3 3 | 80 | 5 3 | 110 | 7 3 |
| 21 | 1 5 | 51 | 3 4 | 81 | 5 4 | 111 | 7 4 |
| 22 | 1 5 | 52 | 3 5 | 82 | 5 5 | 112 | 7 4 |
| 23 | 1 6 | 53 | 3 6 | 83 | 5 6 | 113 | 7 5 |
| 24 | 1 7 | 54 | 3 7 | 84 | 5 6 | 114 | 7 6 |
| 25 | 1 8 | 55 | 3 7 | 85 | 5 7 | 115 | 7 7 |
| 26 | 1 9 | 56 | 3 8 | 86 | 5 8 | 116 | 7 8 |
| 27 | 1 9 | 57 | 3 9 | 87 | 5 9 | 117 | 7 8 |
| 28 | 1 10 | 58 | 3 10 | 88 | 5 9 | 118 | 7 9 |
| 29 | 1 11 | 59 | 3 11 | 89 | 5 10 | 119 | 7 10 |
| 30 | 2 0 | 60 | 3 11 | 90 | 5 11 | 120 | 7 11 |

¼ hr., 0d. ¼ hr., 0d. ¼ hr., 1d.

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Fig. 2.

do not get lost. I repeat, therefore, that for permanent records give me a book. It would perhaps be better to roughly sketch the progress through the works of each order obtained for a set of engines. As soon as an order is obtained a number

* Abstract of Paper read before the North-East Coast Association of Secretaries and printed in the "Journal" of the Association.

is given to it; the estimating department writes up the sizes, etc., in a printed specification which is handed on to the drawing office chief, who forthwith issues blue prints to the pattern shop for iron castings and brass castings. The pattern shop either alters old patterns or makes new ones, and these with a duplicate order are sent into the iron foundry and brass foundry, whilst the drawings for the forgings, smith's work, copper pipes, machinery and fittings, go direct to their respective departments. All labour and materials are charged up to the number given, and then the labour in the various departments, except the brass foundry, iron foundry and forge, begins to find its way into the general office from the time board on the following principle: time board, time book; and for convenience in journalising or abstracting we have separate time books for each shop or department, distinguished by alphabetical

sent weekly by money order or otherwise. For instance, as showing the variety and world-wide character of our speciality department, we have had chargemen or squads of men in Australia, New Zealand, Germany, Belgium, Switzerland, Italy, Spain, and Portugal; and at home, at the present time, we have men working at London and Glasgow, Edinburgh, Dublin, Liverpool, Rochdale, Eastbourne, Hebburn, Carville, Spennymoor, Cargo Fleet, South Hants, Derwent Colliery, etc. As soon as a workman or chargeman is sent away his name is transferred from the department in which he has been working and entered in the outside contract book. Before starting this book, if a turbine man was sent away, his name remained in the turbine book; if a fitter, his name remained in the fitting shop book; if an electrician, his name remained in the sundry or C and D book. Now, however, instead of having to think in

Labour Journal. PAY No. 6. ENDING OCTOBER 3rd, 1907.

| No. of Clocker. | Particulars | Hours | Pattermakers | | | Joiners | | | Wagon and General Labourers | | | | Coppersmiths | | | | Draughtsmen | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Pattern-making | Foreman 6d. to the £. | Total. | Joiners | Foreman 6d. to the £. | Total. | Wagons. | Labour. | Foreman 2/6 to the £. | Total. | Copper-smiths. | Turner 2/6 to the £. | Foreman 2/6 to the £. | Total. | Draughts-men. | Perm. 2/6 to the £. | Total. |
| | | | £ s. d. | s. d. | £ s. d. | £ s. d. | s. d. | £ s. d. | £ s. d. | £ s. d. | s. d. | £ s. d. | £ s. d. | s. d. | s. d. | £ s. d. | £ s. d. | s. d. | £ s. d. |
| 1309 | Engines ... ... | | ... | ... | ... | ... | ... | ... | 5 5 - | 5 1 4 | | 5 1 4 | ... | ... | ... | ... | ... | ... | ... |
| 1233 | ... ... ... | | 0 0 7 | 0 1 | 0 0 8 | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 1234 | ... ... ... | | ... | ... | ... | 0 2 5 | 0 0 | 0 2 5 | ... | 0 5 5 | 1 6 | 0 6 11 | 3 12 9 | 0 6 | 13 10 | 4 15 1 | 0 17 6 | 2 1 | 0 19 7 |
| ... | ... O.B. ... | | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | 2 0 6 | 4 0 | 7 7 | 2 12 10 | ... | ... | ... |
| 1238 | ... ... ... | | 0 0 4 | 0 1 | 0 0 5 | 0 2 3 | 0 0 | 0 2 3 | ... | 0 1 6 | 0 5 | 0 1 11 | 0 2 11 | 0 4 | 0 6 | 0 3 9 | ... | ... | ... |
| 1241 | ... ... ... | | 0 5 9 | 0 6 | 0 12 3 | 0 6 1 | 1 3 | 0 7 4 | ... | 0 1 9 | 0 6 | 0 2 3 | 3 0 9 | 7 1 | 11 4 | 3 19 1 | 0 2 4 | 12 2 | 0 14 6 |
| 1242 | ... ... ... | | 0 19 8 | 1 9 | 1 1 5 | 0 2 5 | 0 0 | 0 2 11 | ... | ... | ... | ... | 0 13 6 | 1 7 | 2 6 | 0 17 7 | 1 16 7 | 4 2 | 1 19 9 |
| 1243 | ... ... ... | | 2 12 3 | 4 7 | 2 16 10 | 0 2 11 | 0 0 | 0 2 7 | ... | 0 6 2 | 1 0 | 0 7 11 | ... | ... | ... | ... | 1 16 6 | 4 7 | 2 3 1 |
| 1244 | ... ... ... | | 0 3 9 | 0 4 | 0 4 1 | 0 0 6 | 0 0 | 0 0 6 | ... | ... | ... | ... | ... | ... | ... | ... | 0 15 6 | 1 10 | 0 17 6 |
| 1245 | ... ... ... | | 0 5 10 | 0 5 | 0 6 3 | 0 1 6 | 0 0 | 0 1 9 | ... | 0 0 1 | 1 2 | 0 0 3 | ... | ... | 1 1 | ... | ... | ... | ... |

FIG. 3.

letters. For instance, A is the iron foundry; G, the brass foundry; both these departments are, however, in one book, as the brass foundry has only from twenty to thirty workmen, and the workmen are often under one chief foreman. B is the boiler shop, C and D contains all the small departments—it is a kind of sundry book; in it are pattern-makers, electricians, joiners, masons, general labourers, bonus men, draughtsmen, etc. E is the lathe shop and brass-finishers' department, F the fitting and erecting shops, H the blacksmiths and forge, and O the sheer legs department—the men engaged in putting engines and boilers on board.

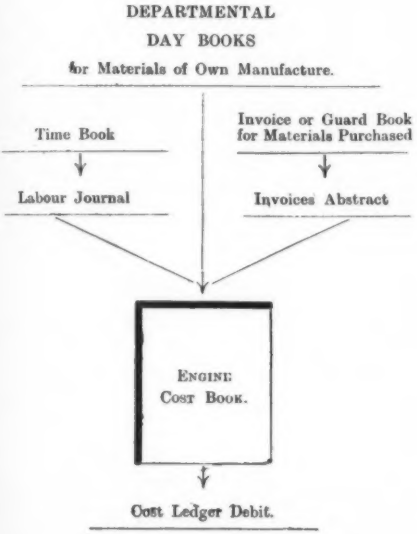
T is the turbine department, and as we have lately developed a large and varied outside staff in connection with our turbine, electrical, contraflo condenser, and cooling tower departments, and are sending workmen to all parts of the globe, I have started a time book for outside contracts; this book contains the men working in other towns, whose money is

which book is the Edinburgh gang, or the Dublin gang, we know that all workmen at outside contracts are in the outside contract book. One timekeeper is responsible for all our time books and enters all time daily (see Fig. 1).

The weekly pays are made up by youths who add up and calculate the value of the labour to each job for the journalist, and calculate the wages. For this purpose, when the fifty-three hours were first granted, I found that most of the wages calculators that were put upon the market were inadequate and unhandy, and therefore I got out one of my own, which has received great praise and is largely used in other engineering offices as well as in our own (see Fig. 2). For convenience in making up the pay and abstracting the labour we have three sets of time books. For instance, one set of time books, from A to O, is used, say, the first week in the month for copying the time into; the second week they are used for making up the pay whilst the timekeeper

is copying the time into the second set of books, and during the second and third weeks, whilst the time books are being used by the pay clerks and journalists and the labour transferred to the journals (see Fig. 3), and engine costs books, the timekeeper is using the third set of books, so that there is never any overlapping, and John Smith can never say that he cannot get on with his work because William Brown is using the time book.

Apparently this looks as though our costs for labour are always three weeks behind. This, however, is not so, because it must be remembered that whilst it is




about a fortnight from Monday to the following Saturday week, it is only a week from Saturday to Saturday, and the last time board used on a Saturday is not copied into the time book until the Monday afternoon, and until that is accomplished you cannot start to make up the pay for the previous week. We also keep a week in hand, and our total time day is on a Saturday. The system, however, is so complete and automatic, and works so well, that the rough cost of a marine engine is usually on the manager's desk on the day of the trial trip. The finished cost can be on the manager's desk within a week of the trial if necessary, but it is seldom necessary, and therefore, in the ordinary routine of waiting for invoices and entering up from day books, etc., the finished cost is completed within three to four weeks after the trial trip. I have devoted considerable space to the labour part of the costs, because in the making up of pays, paying wages and abstracting the same, there is a good deal of general office routine necessary.

I think perhaps here I may describe the method adopted for adding our "on-cost" of unskilled labour. Each department is dealt with separately. Take as an example the boiler shop; each week the total wages paid to skilled labour are, say, £400; for unskilled labour, £100, being equal to 5s. in the £, of skilled labour; so that every job, whether for contract, jobbing work, or establishment charges, bears, in addition to the direct cost of skilled labour, 5s. in the £ as the "on-cost" for unskilled labour. The foremen are dealt with in the same way; say, £400 skilled labour foremen, £10, being equal to 6d. in the £ on skilled labour; every job passing through the boiler shop bears an "on-cost" of 6d. in the £ for foremen's salaries. During a holiday any unskilled labour goes direct to the job the men are working upon, the foremen's salaries during a holiday being debited direct to establishment charges. Each shop is dealt with in the same way. Sundry unskilled labour, such as firemen, enginemen, storekeepers, bonus clerks, etc., are charged direct to establishment charges and not to contracts; managers' salaries, works managers' salaries and clerks, etc., are, of course, also charged direct to establishment charges. Every month we get out the total works or establishment charges, and the total expended upon wages, skilled labour, unskilled labour, and foremen's salaries, also the total expended upon invoices for goods purchased; thus, say, for one month our total wages and salaries are £10,000; our total invoices, say, £20,000; total expenditure, £30,000. We then get out our establishment charges, repairs, upkeep of machinery, clerical and managers' salaries, say, amounting to £3,000; thus our working charges are 10 per cent. We have a diagram, and upon this diagram is shown monthly the total expenditure on labour and material and total expenditure on works or establishment charges. Thus every month the estimating department is in touch with the working and establishment charges, and they add an average working charge accordingly when tendering before adding their anticipated profit, the latter being ruled by the state of the market. The leaves already referred to, taken from a time book and labour journal, give some idea as to the amount

of detailed clerical work in a large concern such as ours, with so many specialities, and which we consider necessary to prevent leakage.

The cost of a contraflo condenser or a set of pumps takes almost as much making up as a marine engine. In addition to

FIG. 4.

this we have a very complete system of keeping the costs of our factory or establishment charges. We keep the cost of the upkeep and repairs to every machine and shop in the works; the consumption of gas, water, coals, etc., is ascertained and checked weekly by a system of comparative columns, and all these are charged to establishment charges. In addition to all this we have departmental cost books for ascertaining the cost per ton of iron castings and forgings, the cost per pound of making brass castings and copper pipes; these, however, I cannot describe within the limits of a paper on engine costs, although in ascertaining the cost of a set of engines they are important and necessary factors, especially in a large firm such as ours, where we manufacture all our own castings and forgings and make our own copper pipes. Each of these departments—I mean brass foundry, iron foundry, forge and copper shop—is treated as a separate establishment, as though it belonged to another firm; rents, rates, taxes, insurances, gas, water, electric light, and electric power are apportioned to each as establishment charges, and when the cost per pound or per ton is ascertained a certain percentage of profit is added and the engines debited with the cost of each article manufactured, just as though we had purchased from outside. The diagram here given shows the routine of labour and articles of our own manufacture and articles purchased. The credits being the invoice price of engines direct from invoice copying book.

We, however, are not concerned with the cost ledger, our enquiry ending with the cost book. Every week the value of the labour is entered into the engine cost book; every week the weight and price of articles of our own manufacture are entered direct from the day books into the engine cost book; every month the materials purchased are entered direct into the engine cost book from the invoices abstract. We now come to the engine cost book itself. I have shown in the diagram how that labour and materials of our own manufacture and materials purchased are entered direct to the engine cost book. Take the question

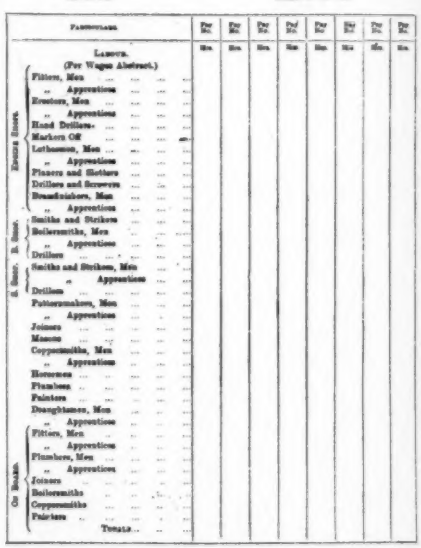


FIG. 5.

of labour. When we started the one book for one engine system, we ascertained the period usually covered from the time the drawing office received the order to the date of the trial trip; we then made provision in every cost book for so many weeks' labour. In the same way we very carefully ascertained how many separate

pages in the books were devoted to iron castings, brass castings, forgings, copper pipes, stores, invoices, etc., and then apportioned so many pages in each book to the various departments. For instance, to iron foundry so many pages are devoted, so many pages to brass foundry, forgings, copper pipes, stores, and so on, and it is surprising how near were our calculations of the actual number of pages required. We have only had one engine so large that it was found necessary to increase the number of pages allotted to it, and in addition to it being a large set of engines it was also a twin screw. In this case we sent the book back to the

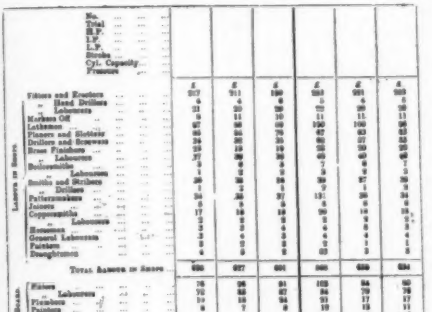


FIG. 6.

printers, who took it to pieces and inserted the extra pages necessary.

The labour abstract clerk enters into each engine cost book all the labour. The day book clerk enters into it all brass castings, iron castings, forgings, smith work, stores, etc. When the steamer is about finished and all the labour and materials are entered up, the engine cost clerk summarises, compares, and finally finishes off and inks in. The most important work is, however, the comparison or checking of labour and materials to see that all are properly charged, and to guard against the mistakes that happen even in the best of regulated works and offices. Our system is such that mistakes are reduced to a minimum. Take the large weights of iron castings and forgings. We have a book in which is printed the names of all iron castings and forgings (see Fig. 4). Each page is devoted to a certain sized engine. Every week a youth enters from the iron foundry day book, forge day book, and brass foundry day book the weights of all rough castings and forgings; thus a comparison or bird's-eye view is made between every engine about the same size. Should there be any great discrepancy or variation in the weights, attention is at once drawn to it before it is transferred to the engine cost book, and it is explained or corrected.

The diagram of castings and forgings is taken from the engine weights book. It will be observed that there is very little variety in the weights, any doubtful weight having been enquired into and corrected within a week or a fortnight of its manufacture in the shop, this being a very important point. A foreman or works clerk may remember any alteration two or three weeks after, though it would be too much to expect him to remember three or four months after.

These books serve the purpose of being a continual check upon the works and are also of considerable assistance to the engine cost clerk, because, in addition to being a check upon the weights, they are a check against each department where the clerical work is frequently done by handy men, that is, better class labourers or failures in clerical life, and therefore these men are not so accurate as a trained clerk. The weights book is a most important factor in checking the accuracy of engine costs. It acts also as a healthy check against a department where piecework or tonnage is paid upon weights turned out. Then, so far as faulty castings or forgings are concerned, any casting or forging that turns out faulty during the process of manufacture and has to be replaced is not put through the books, and the iron foundry or forge suffers to that extent; but if the casting or forging turns out faulty after leaving the iron foundry or forge, from some cause over which the iron foundry or forge has no control, then the second casting or forging is put through the books and the department gets credit for making two castings or two forgings. But as an engine cannot fairly be debited with the cost of more than the castings or forgings that are actually put on

board, we raise a head in the cost ledger called "recast and reforge account," and all such castings and forgings are debited to this head. At the end of the financial year that is analysed, and the total weight of iron castings charged to recast account is calculated at scrap price and debited against the iron foundry; the difference between the scrap price and the original sale price of the casting is debited to profit and loss account. The same is done with brass castings and forgings, each department being debited with the scrap value, the assumption being that all spoilt iron castings will find their way back to the iron foundry, brass castings to brass foundry, and forgings to forge, etc. This is done as an act of justice to the department, and is also necessary because of the departmental cost books that we keep for each department. We also check our labour in the same way, devoting a page to each sized engine or group of engines, and entering the value, not the hours, of work to every class of workman, as shown in Fig. 6. In addition to this, although it has nothing whatever to do with the costs of the engine, and is kept for management purposes only, we have a labour book into which is entered the hours worked on each marine engine contract (Fig. 5).

Let us now more carefully examine some of those checks against inaccuracy and increased costs in the works. We will take the labour first. Here are two pages out of the comparative costs of engines books (see Fig. 6). The names of the steamers are omitted, as are also the numbers and sizes of the engines. They would perhaps drive a ship, say, larger than the "Turbinia," and not quite so large as the "Mauretania," say somewhere in between those two. The figures, however, are actual figures taken from the costs of engines built at the Hartlepool Engine Works. Each page of the book is devoted to engines of one size, or as near to one size as possible. For instance, one page is devoted to engines 40 in., 60 in., and 100 in. by 60 in., another is devoted to engines 50 in., 70 in., 110 in. by 65 in., and another 22 in., 35 in., 59 in. by 39 in., and so on. In Fig. 6 two of the engines are practically from the same specification; the third differs slightly, though the difference is so small that we have assumed that all three engines are the same size. For whilst the h.p. and l.p. cylinders are an inch more in diameter, the stroke is an inch less, so that for all practical purposes of comparison they are near enough in sizes to occupy the same page. By this system the slightest variation in costs is detected and any difference easily explained. Anyone conversant with costs knows that in the case of three repeats, the first invariably costs more in labour than the second and third, the explanation being that the men always work slower at a new job, their tackle and gear requiring some slight alteration. They work more cautiously, lest they make a mistake, and in various little ways the cost of the first of three or six engines is invariably the highest in labour. Observe fitters and erectors in the first set of engines; the first is £217, the next

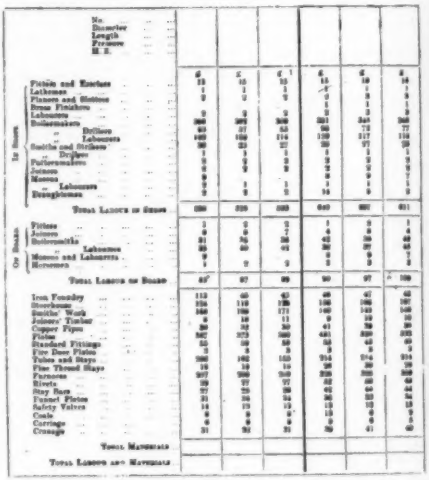
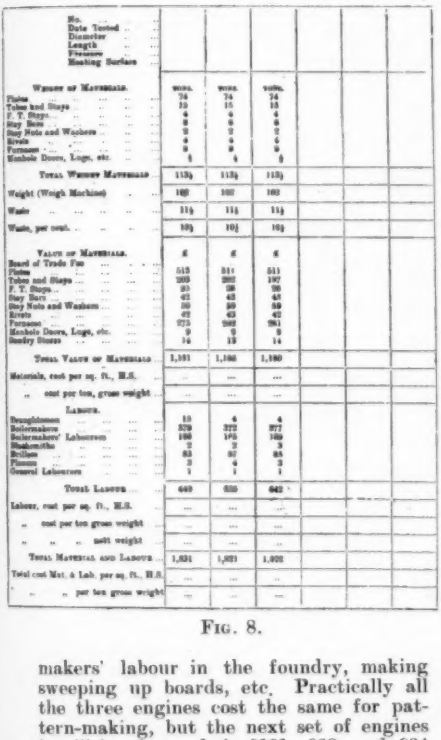


FIG. 7.

£211, and £190. In the next group it will be observed the cost is £253, £221, and £203. Experience over a great many years has taught that this gradual reduction on repeat jobs must be expected. Take the next highest figure in the first group of engines, namely, lathesman £97, £88, £89; planers and slotters, £85, £84, £78. If these figures should not work out in this way we then find out for our overtime and night shift records, during the time these engines were building, the amount of overtime and night shift worked, and in this way we ascertain the causes for any abnormal cost of a repeat job. Take an engine built entirely on night shift or during overtime, if such were possible or necessary, the cost of such a job would increase 50 per cent. at least, because the men received 25 per cent. to 50 per cent. extra for working

overtime and night shift, and Nature, which is a hard task-master, never allows the men to work as hard after 5 p.m. as before. Take an engine worked at continuously day shift and night shift from start to finish; the cost of labour is increased by fully 30 per cent. at least, whereas little or no overtime always decreases costs and increases profits.

A word about pattern-makers here; in the case of this first group of engines the patterns have only been slightly altered, new numbers put on them, and pattern-



| No. | | | |
|---|---|---|---|
| Date Tested | | | |
| Diameter | | | |
| Length | | | |
| Pressure | | | |
| Heating Surface | | | |
| **Weight of Materials.** | tons. | tons. | tons. |
| Plates | 74 | 74 | 74 |
| Tubes and Stays | 15 | 15 | 15 |
| F. T. Stays | 4 | 4 | 4 |
| Stay Bars | 6 | 6 | 6 |
| Stay Nuts and Washers | 2 | 2 | 2 |
| Rivets | 4 | 4 | 4 |
| Furnaces | 6 | 6 | 6 |
| Manhole Doors, Legs, etc. | 1 | 1 | 1 |
| Total Weight Materials | 113½ | 113½ | 113½ |
| Weight (Weigh Machine) | 103 | 103 | 103 |
| Waste | 11½ | 11½ | 11½ |
| Waste, per cent. | 10½ | 10½ | 10½ |
| **Value of Materials.** | £ | £ | £ |
| Board of Trade Fee | 513 | 511 | 511 |
| Plates | 199 | 202 | 197 |
| Tubes and Stays | 30 | 30 | 30 |
| F. T. Stays | 42 | 43 | 43 |
| Stay Bars | 39 | 39 | 39 |
| Stay Nuts and Washers | 47 | 43 | 42 |
| Rivets | 273 | 262 | 261 |
| Furnaces | 9 | 9 | 9 |
| Manhole Doors, Legs, etc. | 14 | 13 | 14 |
| Total Value of Materials | 1,101 | 1,100 | 1,100 |
| Materials, cost per sq. ft., H.S. | ... | ... | ... |
| " cost per ton, gross weight | ... | ... | ... |
| **Labour.** | | | |
| Draughtsmen | 13 | 4 | 4 |
| Boilermakers | 279 | 272 | 277 |
| Boilermakers' Labourers | 198 | 195 | 189 |
| Blacksmiths | 2 | 2 | 3 |
| Drillers | 63 | 57 | 55 |
| Plumbs | 3 | 4 | 3 |
| General Labourers | 1 | 1 | 1 |
| Total Labour | 669 | 635 | 642 |
| Labour, cost per sq. ft., H.S. | ... | ... | ... |
| " cost per ton gross weight | ... | ... | ... |
| " " " nett weight | ... | ... | ... |
| Total Material and Labour | 1,831 | 1,821 | 1,822 |
| Total cost Mat. & Lab. per sq. ft., H.S. | ... | ... | ... |
| " " " per ton gross weight | ... | ... | ... |

FIG. 8.

makers' labour in the foundry, making sweeping up boards, etc. Practically all the three engines cost the same for pattern-making, but the next set of engines it will be observed, is £131, £38, and £34 (see Fig. 6). In this case there were two new cylinder patterns made. Then take the draughtsmen; in the case of the first three engines the drawings were only to be marked up; in the case of the second group new sets of drawings had to be got out for the two cylinders and connections, thus the first set of engines in the second group cost £63 for draughtsmen, whilst in the next two sets the cost was only £3. It may be asked, is not this likely to mislead the estimating department? Not at all. We always charge the cost of new patterns and new drawings to the first set of engines that use them—thus the estimating department when tendering for a repeat order deducts the cost of new patterns and allows £3 to £30 for marking up drawings, and £30 to £100 for pattern-making, according to the size of the engines tendered for.

The question of labour on board can also be checked by this comparative system, though not so accurately, because nearly every ship has a differently arranged engine room. Take the first group of three engines; the first engines were supplied to a ship built by A, the second and third engines for steamers built by B. In the latter case the second and third cost more because of differently arranged engine rooms. Then also a factor that very seriously affects the on-board labour is the length of time between the launching and trial trip dates. The boat is launched, brought to the sheer legs, returned to the shipbuilders, and is away on her trial trip in four to six weeks. This boat will cost considerably less in on-board labour than another boat, which, for reasons over which the engine builder has no control, may be kept floating about three or four months before trial. During this time men must be kept on board, and the longer a ship is kept afloat before trial the greater certainty is there of the costs increasing.

In the case of the plumbers' time, that is affected by the weight of lead pipes fitted on board. In the first two cases the weight of lead pipes was 33 cwts., in the latter the weight was 39 cwts., and it will be observed that the plumbers' time rises accordingly, the labour being £19, £18, £24. In the second group the figures are £21, £17, £17, whilst the weight of lead pipes was 40 cwts., 34 cwts., and 35 cwts.

Another example, as showing how effectual is the check by this comparative system. Take joiners; in the first group of engines the joiners' labour is £19, £21, £23. Referring to wood used by joiners—and we always make a distinction between wood used by joiners and wood used by pattern-makers—the value of the wood used by joiners was £34, £38, £42, necessitating therefore more joiners' labour. In the second group of engines the joiners' labour is a decreasing quantity, being £27, £22, and £22, the value of the wood used being £36, £30, and £31.

Then, again, take pattern-makers. First group of engines; Pattern-makers'

labour, £34—wood used, £1; £35—wood used, £2; £37—wood used, £9. In the latter case an alteration was made to one of the patterns. Second group of engines: Pattern-makers' labour, £131—wood used, £16; £38—wood used, £7; £34—wood used, £2. In this case two new cylinder patterns were made and charged, according to our practice, to the first engine that used them.

Take brassfinishers, and we can easily compare here, because we have a brass-finishing shop where brass castings only

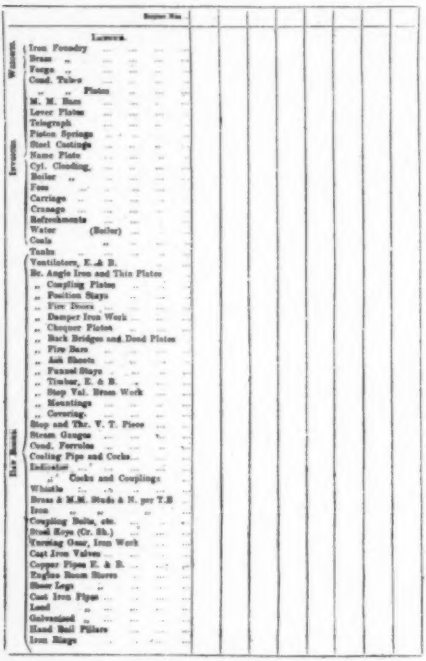


FIG. 9.

are finished. Brassfinishers' labour; First engine, £23; brass castings, £401; second engine, £18; brass castings, £374; third engine, £19; brass castings, £348. In the first engine a large spare liner was supplied. In the second and third engines it was found that there was a difference in the weight of the large liners of over 4 cwts. which, added to a slight reduction in the price per pound of brass castings, accounted for the difference in value of brass castings, whilst the labour would be very little affected. These are actual figures taken from our engine cost books, and again show how easy it is to check increased costs of either labour or material by the comparative cost system.

Now let us look at some of the figures where it is not so easy to check by comparing labour and material. Take copper pipes:—

| | Coppersmiths' labour. | Copper pipes. | Weight. |
|---|---|---|---|
| First engine ... | £17 | £66 | 11¼ cwts. |
| Second ,, ... | 16 | 77 | 12 ,, |
| Third ,, ... | 18 | 79 | 12 ,, |

In this case copper pipes ought to have been about the same, but it will be perceived they increase by 17 per cent. as between the first and second engines. Two reasons may be assigned for this. In the first case the superintendent may have accepted a steel main steam pipe instead of copper, but the weight checks this, the weight in all three cases being about the same. Our next inquiry is as to the state of the market, and we find that whilst the first engine was building, copper tubes were 8¾d. per lb., but in the second and third cases 10d. per lb., or 17 per cent. increase.

Now let us take iron castings: First engine, £870; second engine, £931; third engine, £943. In the case of iron castings a heavier weight would affect the labour of certain departments, though not to such an extent as, say, in the manufacture of copper pipes or patterns, but in these cases the weight of iron castings remained practically the same, being 85¾ tons, 86¼ tons, and 86½ tons, so that we must again look to an outside source. The most superficial knowledge of the markets, or the most cursory glance at our departmental cost books, showed the following:—

| | Cost. | Average cost per ton. £ s. d. | Weight. Tons. | Pig-iron Per ton. s. d. |
|---|---|---|---|---|
| First engine | 870 | 10 2 9 | 85¾ | 44 3 |
| Second ,, ... | 931 | 10 15 9 | 86¼ | 47 6 |
| Third ,, ... | 943 | 10 18 0* | 86½ | 50 0† |

* Increase, 14 per cent. † Increase, 13 per cent.

Therefore the rise in the pig-iron market was the explanation, so that again the almost scientific accuracy of the comparative system will be seen.

I think we have pretty well exhausted our remarks on the engines; we will now take the boilers. We adopt the same methods of checks as in the case of engines, namely, devoting one page to several boilers the same size. In the case of the boilers, we ascertain from the drawing office the diameter, length, pressure, and heating surface. In the case of the labour, there is nothing calling for remark in any of the six boilers, excepting in the case of the draughtsmen in the second group of boilers (see Fig. 7).

The draughtsmen's labour is £14, £5,

and £2. An inquiry in the drawing office at once elicited the information that in the case of the first boiler an alteration in the design of the boilers necessitated a new set of drawings. In the first group of boilers our own masons and labourers covered them with boiler covering of our own manufacture, whilst the second and third boilers were covered with a special mixture supplied and put on by an outside firm. This accounts for the masons and labourers costing £9 on the first boilers and nothing on the second and third, whilst in the case of the second group all three boilers were covered by our own men, the labour for which was £8, £9, and £7. In comparing the materials the differences are easily accounted for. Take the first item, iron castings; instead of our own firebars being supplied, they were patent firebars. which accounts for the castings being £113 in the first set of boilers and £45 in the other two sets. The difference in the stores is accounted for by the fact that in the first boiler is included the cost of our own boiler covering. The next difference is in the boiler plates, which is accounted for by an increase in the price of boiler plates. It will be observed the first group increases from £367 to £373 and £380, whilst the second increases from £481 to £520 and £532. Another difference is in the tubes and stays, which drop from £206 to £162 and £155, the explanation being that in the first case 65 per cent. was allowed off the list price, whilst in the other two 72½ per cent. and 73¾ per cent. were allowed. The next item calling for remark is the furnaces, which drop from £257 to £209, the explanation here being that in the two latter cases the furnaces were a little lighter and prices dropped £2 10s. per ton.

It will have been observed that so far as the principal weights are concerned, namely, brass castings, iron castings, and forgings, these are checked every week, and therefore when the engine cost clerk takes up his duties, which is generally when the date of the trial trip is settled, he knows that in the three principal component parts of the engines the weights have been checked from week to week and any differences explained and marked in the weights book. So far as all other departments are concerned he can only check them after the costs of the engines are roughly made up; this is always done on or about the time of the trial and before he enters his final figures in the summary. The engine costs are made up showing the cost of labour in the shops and on board. The boiler costs are made up in three sections; first, as soon as the boilers are tested in the shops (Fig. 8), as they are all done, under hydraulic pressure. Thus we get the cost of every boiler in the boiler shop before any fittings or mountings are on it; second, the boiler mountings, including brass valves, etc., thin plates, funnels, gratings, etc.; and, third, the on-board cost.

The first thing that the cost clerk does when he tackles the cost of an engine is to see that every important part of an engine has been charged. This he does with the aid of another comparative book (Fig. 9), nothing being left to memory. In fact, all the books having been exhaustively compared, criticised, and amended, the clerical work proceeds almost automatically, and with the accuracy and care of a trained cost clerk the making up of the cost of an engine is very much simplified by the comparative cost system.

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## THE BRASS CASTING REGULATIONS.

### Conclusion of Inquiry.

The inquiry into the Home Office regulations concerning the disease affecting brass casters and the measures for mitigating it, which was held in December last at Birmingham, and afterwards at Glasgow, concluded last week in London. The Home Office was represented by Mr. Thornton Lawes, the Brass Masters' Association and Birmingham Chamber of Commerce by Mr. J. J. Parfitt, the National Society of Amalgamated Brass Workers and Metal Mechanics by Mr. W. J. Davis, and the Engineering Employers' Federation by Mr. A. M. Smith.

Further evidence was given on behalf of the Engineering Employers' Federation in opposition to the evidence given in Birmingham that the malady called "brass founders' ague" prevailed, especially in the smaller shops, and to show that the regulations affecting the lavatory requirements were either too stringent or were unnecessary. The witnesses said they spoke for shops in which there was a very small percentage of yellow brass castings, and in which the proportion of zinc used as an alloy was also small. One witness stated that in his opinion zinc oxide was not a poisonous substance; it had been tested, and it had been found that a pound per week had been administered to human beings without bad effect.

The COMMISSIONER thought that a strong body of evidence was produced at Birmingham to show that the malady, whatever it was called and however caused, did, in fact, exist, though in varying degrees of seriousness according to the conditions of the particular shops.

MR. PARFITT, in addressing the Commissioner on the whole case, submitted that the extent of the malady was not so great as some of the Birmingham witnesses called by the Home Office had suggested, that therefore the draft regulations as they stood were much too stringent, and that the question of ventilation must be very carefully dealt with so as not to hamper or spoil strip casting or ammunition work, and impose an unfair burden upon sand casters. He discussed at length with the Commissioner a form of suggested amended regulations which he said would probably meet the fair requirements of the case, and turn out to be workable.

MR. SMITH contended that the weight of castings made in the North was so different from those in Birmingham that his clients ought to be exempted very largely from the regulations, and he suggested various alterations with a view of making the draft regulations, if possible, more suitable to the work carried on by his clients.

MR. DAVIS said that he was only objecting technically, and that he was really supporting the Home Office case, which showed that brasscasters' ague did certainly exist, and that further regulations were essential to deal with the question of ventilation of the casting shops, lavatory requirements, and other matters.

MR. THORNTON LAWES, in replying for the Home Office, said that it was hoped that the regulations would be sufficiently elastic to cope with the real dangers of brass-casting work, and not press unfairly upon employers, and he submitted that the evidence had established a condition of things which required to be dealt with.

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IT is reported that the Great Northern Railway Company of Ireland intend at an early date to transfer their locomotive works from Dundalk, County Louth, to Belfast. The directors of the Company have had the scheme under consideration for some time, one of the principal reasons which actuated them in their decision being the necessity for acquiring greater scope and facilities to meet the increasing demands of their service.

## ADDING CONTRACTION TO IRREGULARLY SHAPED PATTERNS.

ONE of the most important factors in a pattern is to make the necessary provision, so that the work when cast, will turn out perfectly "true" to size and shape.

There is no question by which the experience of a pattern-maker can better

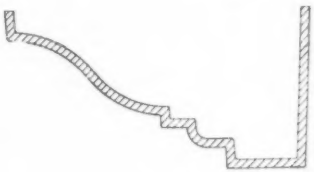

FIG. 1.

be judged, than how he deals with this important subject.

When we talk of contraction, one unversed in the physical properties of cast iron, or its behaviour when cast under certain conditions, might be of opinion that the only question to be considered when making a pattern is to make it, say, $\frac{1}{8}$ or $\frac{1}{10}$ of an inch per foot larger than the actual size of the casting, and the work

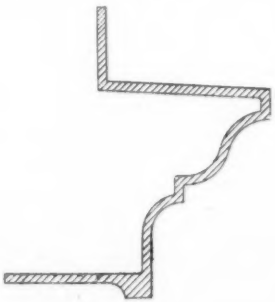

FIG. 2.

when cast will turn out perfect to shape and size. Foundrymen who have had experience with work embracing irregular sections, such as in cast iron gutters, or work of a similar character, know that a great deal more has to be considered than merely the addition of this $\frac{1}{8}$ or $\frac{1}{10}$ of an inch per foot.

Certain provisions have to be embodied in the patttern according to its shape and

cross sectional area, to prevent the work becoming bent and otherwise out of form when cast.

There is perhaps no branch of the foundry trade in which so much uncertainty exists as in determining the amount of contraction and the effect which it will have on certain forms of castings. This is a subject in which there is a splendid field open for scientific investigation. Experience is practically the only method at present available, and although not a very satisfactory mode of procedure, it certainly goes a long way in assisting to overcome the difficulty.

There are few pattern-makers who have not at some time or other found difficulty with this question of contraction, and its application to the aforesaid forms of work. There are many points which must be considered in determining the actual amount of contraction to be allowed for, such as the chemical constituents of the iron, the thickness of the casting, and the conditions under which the work is cast.

This question of contraction affects the moulder possibly as much as the pattern-maker. A great deal can be done by an intelligent moulder in assisting to overcome this difficulty, in so far, that if the work after being treated by the pattern-maker to the best of his ability, is found not to turn out "true" when cast, the moulder can by judicious ramming of the mould, both before and after the work is cast, and in other cases by certain treatment of the casting itself, make a wonderful effect on the work, and in many instances save the remaking of the pattern. This treatment is only possible, of course, after a trial casting has been made. It is not our intention at present to enter into the theoretical considerations which regulate the amount of contraction which should be put on for the different classes of work, nor the various precautions which should be observed by the pattern-maker and moulder, but we wish only to take up one of the practical aspects of this important question, viz., the method by which contraction should be

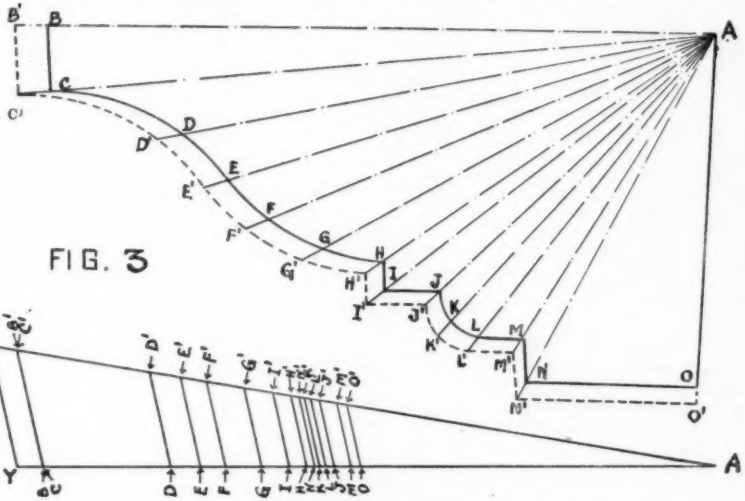


FIG. 3




FIG. 4

added to irregularly shaped patterns, and to make some observations thereon. In actual practice it often occurs that part of an old casting, or a rubbing taken therefrom, is passed to the pattern shop with the following instructions:—"The new castings required are to join existing work, and must be similar in every respect to the sample, or the rubbing, as the case may be."

Where the work is of a plain description there is no difficulty in carrying out the instructions, but when the work embraces mouldings, such as in a cast iron cornice, or ornamental gutter, the opposite is the case.

Work of this class requires special care as to how the necessary contraction is

added, in order that each feature of the new casting will line with, and be similar in every respect to those of the existing work.

It is with this phase of the subject that we in the present article intend to deal.

We shall endeavour to show the correct method by which the contraction should be added to these forms of work, so that each feature of the design shall, when cast, coincide with, and be in every respect similar to that in the original work.

Figs. 1 and 2 show the sections of an ornamental gutter and cast iron cornice respectively. These are two of the most common forms to be met with by the pattern-maker, and may be taken as typical examples of the class of work requiring treatment in this manner.

Let us first consider the case of the cast iron gutter, and assume that Fig. 1 represents an outline taken from an old casting, or is an exact representation of the form for which the new castings are wanted, and to this we are asked to make a pattern.

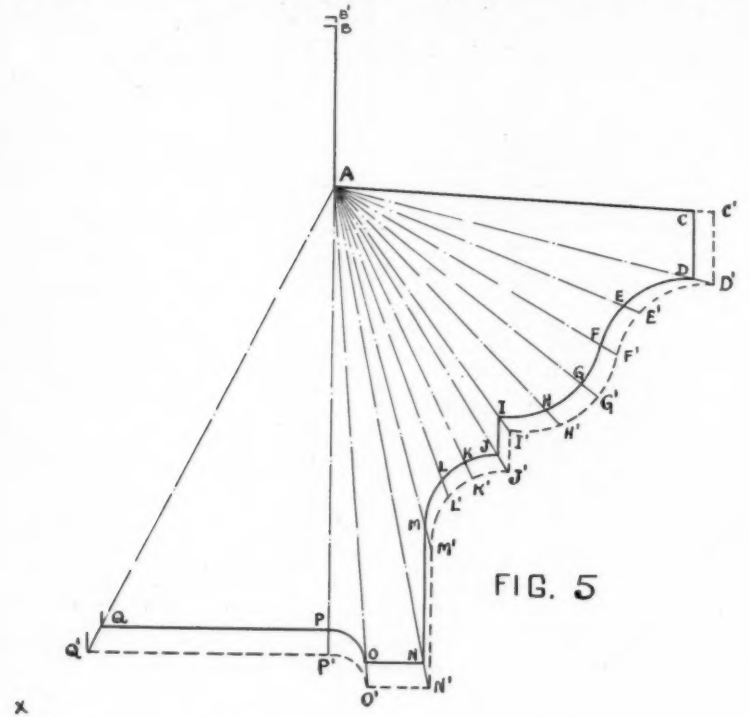


FIG. 5

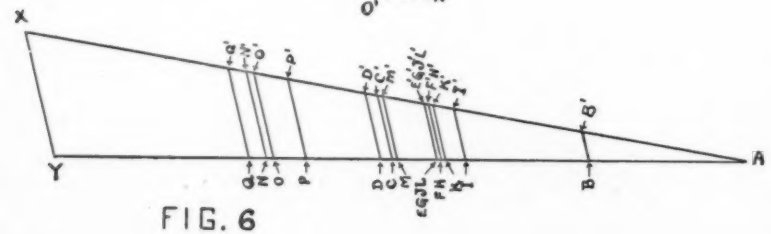


FIG. 6

In order to accomplish this successfully, owing to the irregularities of the section, it is necessary before proceeding, to draw

the work down to pattern size; that is, with the contraction added.

It may be stated here that for this, and all other classes of work which are of a "channel" section in form, the most suitable material with which to make the pattern is stucco, and when this is the material decided upon it is absolutely necessary that the work be drawn to pattern size, in order that the gauges for "running up" the work may be made therefrom.

The following is the method to adopt:—Take the case of the gutter and mark a point A (see Fig. 3), at any convenient position, so that lines may be drawn radiating from it, and terminating at each of the important features in the design as shown.

These act as construction lines on which the new outline, with the contraction added, will be built. Now measure each line separately, and add to it one or two contractions, as the case may be, and produce each line by exactly this amount, and the ends of the extended lines will give the main points, which, if joined, as shown by dotted line (Fig. 3), will give the correct outline for the pattern.

There are two methods of adding shrink to these construction lines:—(1) With the aid of a contraction rule; (2) by proportion.

The first method is to measure each line with an ordinary rule and then measure the same length with a contraction rule, to one or two shrinks as the case may be; this will give the new outline.

For example, if the distance between A and B (Fig. 3) was 9 in., and our pattern was to be made with two shrinks at the rate of quarter of an inch to a foot, the new point, $B^1$ (Fig. 3), would be $9\frac{3}{16}$ in. distant from **A.**

The same process being adopted with the other lines AC, AD, and so on, we get the points $C^1$, $D^1$, etc.

The second method, the one to which we wish specially to draw attention, is one which should be known by all foundrymen, and as its principles are based on scientific lines its accuracy cannot be disputed.

The construction is shown in Fig. 4.

If any size on the work under consideration does not exceed 12 in., draw the line AY, 12 in. long. We will assume the work is wanted with double shrink at the rate of a quarter of an inch to a foot.

Now draw AX $12\frac{1}{4}$ in. long to any angle with AY.

Now measure AB on Fig. 3, and mark a point B on the line AY, making the distance from A to B on Fig. 4 equal to AB on Fig. 3, and so on, with the other sizes AC, AD, etc., until we have all the sizes transferred to the line AY.

Now join YX, and from the points B, C, D, E, F, G, H, I, J, K, L, M, N, and O, draw lines parallel to YX till they meet the line AX, terminating at the points marked $B^1$ to $O^1$.

The sizes now found on the line AX are all in proportion to those on the line AY, but each size has now two shrinks added; that is, $AO^1$ is equal to AO plus two shrinks, and similarly with the other sizes.

Now these sizes are transferred to Fig. 3, as shown, and the line passing through them gives the form of the pattern (shown by dotted line) which, when twice cast will exactly coincide with the original outline shown in Fig. 1.

The treatment for the cast iron cornice (Fig. 5) is worked on exactly similar lines to that explained in connection with the gutter. The construction is shown in Fig. 6.

The advantage of this method is, that it solves the difficulty of adding contraction to forms such as ogees, and parts of curves which have no fixed centre. The foregoing will be appreciated by pattern-makers who are engaged in foundries where a general trade is carried on, as in this class of trade, work embracing these irregular forms is to be met with from time to time.

If the above system be adopted, which is based on that well-known law in mathematics, "Proportion," this trouble about contraction, like all other troubles, when the means of overcoming them are known, will entirely disappear.

Many examples applied in other directions might be given showing the principles involved in the foregoing, but we are of opinion that those given will suffice to illustrate the main points to which we wish to draw attention. We leave the pattern-maker to apply these in the various directions as occasion arises.

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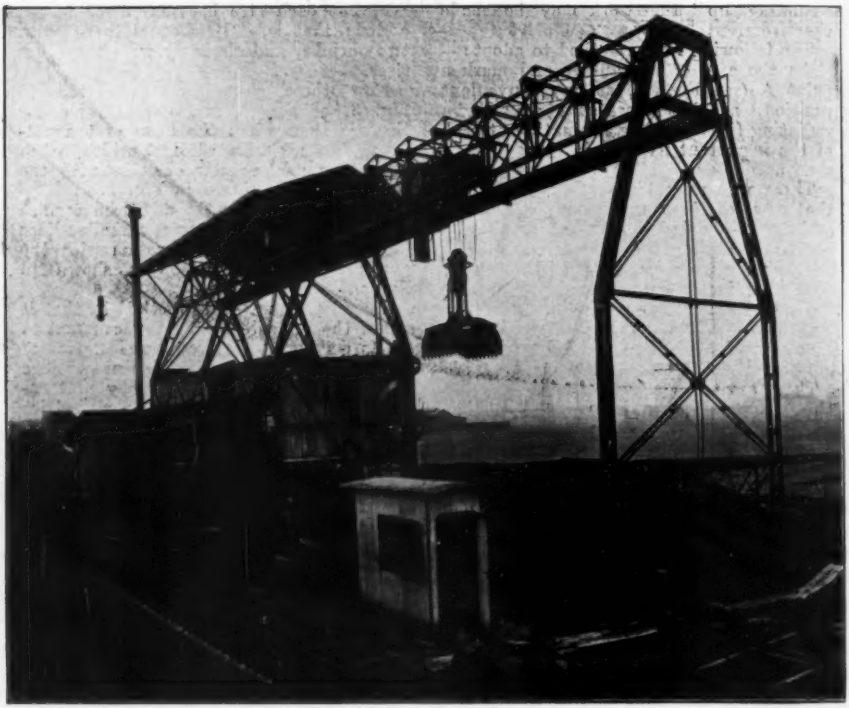
In connection with the census of production, two meetings of the Advisory Committee for the Brass Trades have been held during the month at the offices of the Board of Trade. Those present were:—Mr. A. Wilson Fox, C.B. (presiding), Mr. R. H. Best, Mr. J. Howard Cartland, Mr. R. G. Evered, Mr. J. W. Madeley, Mr. George Sperryn, Mr. W. H. Tonks, Mr. H. Fountain, Mr. H. W. Macrosty, and Mr. G. C. L. Maunder (secretary).

## CRANES FOR STEEL FOUNDRIES.

The employment of travelling electric winches or cranes is found advantageous in many cases in steel works, and is worthy of consideration with regard to the charging of gas producers. A plant of this description, for raising coal from a storage pit to a high level hopper above a set of producers, has been constructed for the Oecking Steel Works (Stahlwerk Oecking, A.G.), Düsseldorf, by Messrs. J. Pohlig, Limited, of Cologne, and is shown in Fig. 1. The coal is discharged from railway wagons into a storage pit, from which it is taken out by grabs. The pit has a sliding roof, to enable coal to be put in and taken out, whilst the dissemination of dust is avoided. The track for the travelling winch is attached to the structure of the generator house in a suitable manner.



ELECTRIC COAL-HANDLING TRAVELLING CRANE AT THE OECKING STEEL WORKS, DÜSSELDORF.

## LIFTING MAGNETS.

Wherever pig-iron, metal plates, tubes, rails, beams, scrap, or heavy iron, and steel castings are to be handled, lifting magnets can be advantageously employed. The saving of time in adjusting hoisting tackle to the object to be raised is of itself oftentimes sufficient to justify the installation of a lifting magnet, while in the case of pig-iron, plates, rails, and scrap, the practical advantages of lifting magnets are still more obvious, owing to the large number of pieces that can be handled at a single lift, and to the fact that the objects to be handled need not be piled beforehand. A further advantage of lifting magnets is found in the fact that metal too hot to be handled by men can be taken care of as easily as cold metal by the magnet.

The design of a lifting magnet is varied

to suit the metal which it is required to handle. The construction of magnets for handling plates, or material of a similar nature, affording an opportunity to secure an intimate magnetic contact, is a comparatively simple problem. Calculations as to the lifting capacity of such a magnet can be made with considerable accuracy as the total flux is easily figured. Magnets for handling billets, etc., laid in piles are, as a rule, operated in pairs, as such material usually comes in lengths up to 30 ft. They are most conveniently handled by two magnets placed 8 ft. to 20 ft. apart on a balancing bar to which the crane hook is attached. Magnets for

FIG. 1.—THE CUTLER HAMMER LIFTING MAGNET.

handling pig-iron, scrap, etc., present considerable difficulty in design, as they are expected to handle a wide range of material, varying in form, in magnetic permeability, and often encountered in irregular piles. This increases the reluctance of the magnetic circuit, and, consequently, the total flux varies with each lift. This makes an accurate calculation of the flux almost impossible, and renders experience essential to the production of a thoroughly good lifting magnet.

The most efficient magnet is usually considered the one which lifts, in proportion to its own weight, the greatest possible amount of material. The weight of the magnet itself must be considered as dead weight, and the aim of the manufacturer is to construct a magnet that will combine the minimum of weight with the maximum of lifting capacity. Other things being equal, the larger the magnet the greater is its lifting capacity. While it is true that the weight of the magnet itself must be considered as dead weight, it may sometimes happen that the heavier magnet may actually be the more economical of the two. The material handled by lifting magnets is usually hoisted and then conveyed. The power required to hoist is directly proportional to the load on the crane hook, but this

FIG. 2.—MAGNET LIFTING 32 PIGS—WEIGHT 2,080 LBS.

does not hold true in regard to conveyance, as the weight of the crane forms a large proportion of the total load to be moved. If a larger dead weight, by lifting more, enables the number of trips made by the crane to be reduced, a marked saving may be shown, both in time and current consumption.

The Cutler-Hammer Clutch Company has recently placed on the market the electro-hoisting magnet, shown in Figs. 1 to 8. This magnet contains features which, it is claimed, mark a distinct advance in the industry. A severe test undergone by one of these magnets comprised the unloading of a railway wagon

containing about 50 tons of sand-cast pigs in two hours and five minutes. A 52-in. magnet was used and the work was accomplished by one man, the crane operator. The average lift of the magnet in this test was 739 lbs. In tests conducted with a similar magnet at the Donora Works of the Carnegie Steel Company, thirty-two sand-cast manganese pigs averaging 65 lbs. each were lifted from the ground by the magnet, a total lift of 2,080 lbs. Under fair average conditions, a 50-in. magnet should handle from 1,000 lbs. to 2,000 lbs. of material at a time, but this may fall to 500 lbs. under adverse conditions, or rise to 10,000 lbs., or even 20,000 lbs. under extremely favourable conditions.

FIG. 3.—MAGNET LIFTING A 5,500-LB. SKULL.

In the design of the Cutler-Hammer magnet the magnetic attraction of the inner pole has purposely been made stronger than that of the outer pole, the practical effect of this concentration of magnetic flux being that in handling pig-iron or similar material the various pieces constituting the load are released by the outer pole first, when the current is switched off, and are drawn toward the centre of the magnet by the superior attraction of the inner pole, thus enabling the operator to deposit the load within an area scarcely exceeding in radius the diameter of the magnet itself.

The following data were obtained during the test of the 52-in. magnet previously mentioned:

| | |
|---|---|
| Total weight of pig-iron unloaded ... | 109,350 lbs. |
| Weight of average lift ... ... ... | 739 lbs. |
| Number of trips required to unload wagon ... | 139 |
| Length of time current was on magnet | 75 minutes. |
| Time current was off magnet ... ... | 50 minutes. |
| Total time ... ... ... ... ... | 125 minutes. |
| Current required ... ... ... ... | 30 amperes. |
| Voltage ... ... ... ... ... ... | 220 |

This gives a total power consumption of 8.25 kilowatt-hours, which, at a rate of 1½d. per kilowatt-hour, gives a total cost of current of less than 2s. for energising

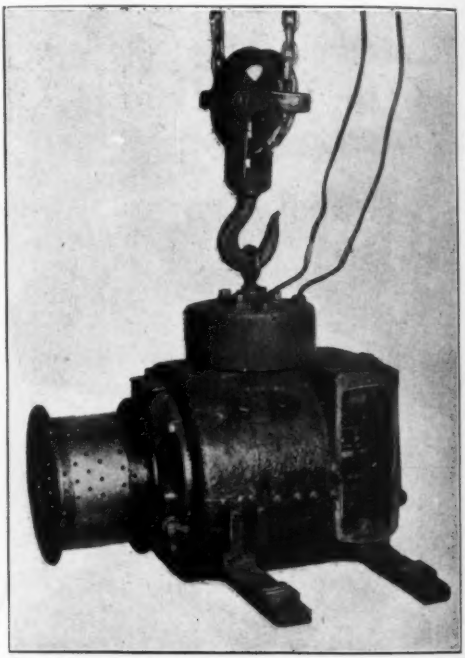


FIG. 4.—10-IN. 75-LB. MAGNET, LIFTING GENERATOR WEIGHING 800 LBS.

the magnet during the period required to unload 50 tons of pig-iron.

This magnet possesses features which tend to give a high efficiency, due to good proportioning of the magnetic circuit, ensuring a deep penetration of the flux into the material to be lifted, and largely to the attention given to the important question of heat radiation. The frame of the magnet is corrugated, which increases the surface available for radiation and, at the same time, forms niches that pro-

tect from injury the heads of the through bolts which fasten the removable pole piece, discussed later, to the magnet frame. Heat radiation is further aided by casting the magnet frame with a central aperture, through which air may freely circulate.

A point worthy of notice in connection with this magnet is the auxiliary pole piece. Lifting magnets of large size, designed for use with pig-iron, scrap, etc., with the object to be lifted. This feature is illustrated in the line drawings, Figs. 5, 6, and 7.

Another feature worthy of mention is the removable pole shoe bolted to the under side of the magnet by through bolts. This part of the magnet is subjected to the greatest wear, and in the present case may be easily renewed, reducing to a minimum the expense for repairs.

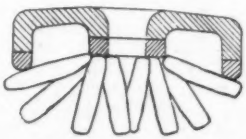


FIG. 5.—MAGNET FOR LIFTING PIG-IRON.

FIG. 6.—PIG-IRON MAGNET LIFTING A PLANE SURFACE PIECE.

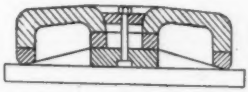


FIG. 7.—MAGNET FITTED WITH AUXILIARY POLE PIECE FOR PLANE SURFACES.

are made concave on the under side, because this form is best adapted to handling large numbers of irregularly shaped pieces of metal at a small lift. When, however, the load consists of one or two large objects with plane surfaces, this cavity becomes objectionable, as an air gap then intervenes between the inner pole and the object lifted. The central aperture in the magnet makes it possible to convert it in a few moments from a concave faced magnet into one adapted to handling large masses of metal with plane surfaces. This is accomplished by inserting in the central aperture an auxiliary pole piece proportioned to extend the inner pole downward to the level of the outer pole, eliminating the air gap and ensuring intimate contact of both poles

Fig. 9 shows a lifting magnet recently brought out by the Cleveland Armature Works, of Cleveland, and known as the "Inter-pole" lifting magnet.

In order to meet all conditions of service, two types of these magnets have been designed and are being manufactured; the "Inter-pole bell magnet," to be used for loose detachable material, as scrap iron, turnings, borings, etc., and the "Inter-pole flat magnet," to be used for material with more or less flat surfaces and in larger pieces, as ingots, heavy castings, etc.

Annexed is a cross-section of the bell magnet, which consists of a heavy, annealed steel casting, which, as the name implies, is bell-shaped. Two magnet coils are used and are so placed in relation to

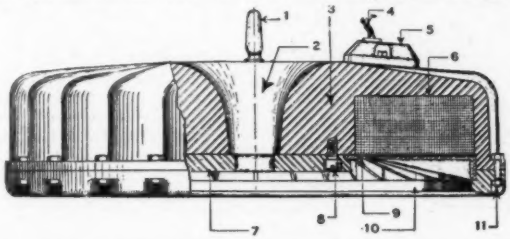



FIG. 8.—INTERNAL CONSTRUCTION OF CUTLER-HAMMER LIFTING MAGNET.

1.—Eye Bolt. 2.—Central flue permitting heat radiation through body of Magnet. 3.—Magnet Body. 4.—Cable. 5.—Nominal Box. 6.—Coil. 7.—Inner Pole Shoe. 8.—Pole Shoe retaining screw. 9.—Coil Shield. 10.—Outer (removable) Pole Shoe. 11.—One of the through bolts fastening removable Pole Shoe to Magnet Body.

each other that they form a solenoid in two steps. These steps are separated by an iron ring termed the "Inter-pole." This arrangement forms an effective magnetic field, which acts with the greatest intensity toward the centre of the magnet. It is also altogether confined within the sphere of the bell. The solenoid action of the coils draws the material to be lifted well up into the bell and the outer shell of the casting extending below the under face of the outside coil, together with a heavy shield of non-magnetic material bridging from pole to pole, protects the magnetic coils and increases the reluctance between the poles, thereby increasing the effective lifting power of the magnet.

The fact that magnetism is confined entirely within the bell is of importance in handling small material, since it enables the magnet to deposit its load within a narrow radius. Were the magnetism not confined in this manner, the material could be scattered over a large surface.

These magnets are manufactured in several sizes, the largest of which is 52 in. diameter, weighing 4,900 lbs. This magnet consumes an average of 20 ampères of current of 220 volts, and will lift from 1,000 to 1,350 lbs. of sand-cast

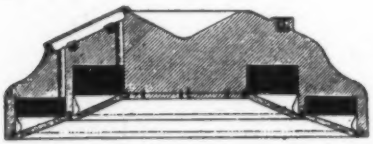


FIG. 9.—SECTION OF "INTER-POLE" BELL-SHAPED LIFTING MAGNET.

pig, or about 1,200 lbs. of plate scrap. Its maximum capacity for one piece is 15 tons, which, the maker states, is a performance unsurpassed by any other magnet. Both types of lifting magnets are manufactured for any voltage desired, and the cable connections are interchangeable to make possible the use of either the bell or the flat magnet on the same crane installation.

We append the results of a test of a 4,900-lb. magnet in handling various materials. The magnet was wound for 220 volts and 20 ampères. During the test the voltage was irregular, most of the time being below 220. At the above voltage, the magnet required 4½ kilowatts per hour to operate it:—

*Sand Cast Pig.*
Average length, 49 inches.

| | Pounds. |
|---|---|
| First lift | 1,350 |
| Second lift | 710 |
| Third lift | 935 |
| Fourth lift | 900 |
| Fifth lift | 870 |
| Sixth lift | 645 |
| Seventh lift | 825 |
| Eighth lift | 905 |

*Plate Scrap.*
3 × 15 × ¼ inches.

| | |
|---|---|
| First lift | 525 |
| Second lift | 600 |
| Third lift | 425 |
| Fourth lift | 505 |
| Fifth lift | 775 |
| Sixth lift | 1,150 |

*Turnings and Borings.*

| | |
|---|---|
| First lift | 500 |
| Second lift | 675 |
| Third lift | 617 |
| Fourth lift | 630 |
| Fifth lift | 575 |

—o—

## THE APPLICATION OF SCIENCE TO FOUNDRY WORK.*

By ROBERT BUCHANAN.

THE founding of metals—that is, the formation of moulds made of refractory materials into which molten metal is poured—is not only a very ancient art, but it is of enormous importance to-day. The ancients made castings of gold, silver, and bronze, all metals having comparatively low melting points. Their fuel and furnaces were inadequate to produce temperatures sufficient to liquify the steel and wrought iron they made. These have been liquified within a very recent period of time. The making of wrought iron and steel, and the casting of articles of bronze, were antecedent to the making of articles of cast iron by many hundreds of years. Some things the ancient worker in bronze had in common with the modern worker in cast iron. These are sand, clay, and straw, symbols of instability in all ages, and his principal care was the provision of suitable means of escape for still more unstable gases.

Were it not that wonderful things cease to cause wonder if they often recur, one would not cease to wonder at the fact that molten metals of high temperature and great fluidity may be confined within the well-defined limits of a mould through which gases pass freely. In certain cases the permeability of the mould by gases has to be so easy, that if one cares to do so one may test the permeability by applying one's mouth to the

* Abstract of Paper read before the Royal Society of Arts, February 12th, 1908.

mould, causing the breath to penetrate it. This applies particularly to that part of a mould called a "core," and is often used as a test; yet such a core will refuse the penetration of molten iron. It may be noted here that this matter of penetrability of moulds by metals varies very considerably. I do not refer simply to the distance a molten metal will penetrate into a crack in the mould, but rather into the apparently solid surface of the mould. Lead penetrates more than brass, and brass more than iron. This penetrability is not a question of temperature, as the lead has the lowest melting point of the three and iron the highest. Probably the specific gravity of each metal has an effect upon penetrability of mould though objection may be made that specific gravity does not wholly supply the reason for greater or less penetrability.

Moulds for cast iron are of three kinds, if we exclude metal moulds for the production of chilled castings, and composite moulds partly metal and partly sand, in which are made castings hard in parts and soft in parts. Rolls for use in iron and steel rolling mills are examples of castings produced in composite moulds of iron and sand. The hard, close-grained body of the roll is produced by the chilling effect of the iron mould, that is, the rapid abstraction of the heat from the molten iron. The softer neck of the roll is obtained by the slower cooling due to the slower absorption of heat by the sand mould at that part.

Excluding these, three kinds of moulds are used as stated. These are green-sand, dry-sand, and loam moulds. Clay is the material which in each of these forms the "bond," and the permissible quantity of clay is greatest in loam moulds and least in green-sand moulds.

Cores are mostly made from mixtures of sand and clay-water, but they are also made from mixtures of sand and resin, sand and dextrine, or "gum," sand and linseed oil, sand and flour, sand and molasses, or treacle; but the last three mixtures named are not much used in Great Britain.

The sand used with these latter substances as a bonding material is usually "sharp" sand—that is, sand practically free from clay, and thus has no cohesion of its own. Sand from the foundry floor, or burnt sand, or a mixture of these, is also used for this purpose. The advantages of using mixtures of this kind are as follows:—The cores are very hard when dried, and stand handling without chipping; they leave a good skin on the casting where the metal touches the core; they facilitate the easy fettling or dressing of castings containing them. Owing to the bonding material being driven off in the form of gas by the heat of the metal run into the mould, only the non-cohesive sand remains, and that is removed with very little trouble. In short, with these mixtures cohesion lasts as long as required, and ceases a short time after the metal surrounds the core, when cohesion is neither necessary nor desirable.

Green-sand moulds are so called because they are cast "green," that is, they are not dried previous to being cast. Dry-sand moulds are made from mixtures of sand which contain more clay than in the case of green sand moulds, and a freer use of water is permissible without risk of defective castings, seeing the moisture is all evaporated by drying the mould in an oven. Thus during casting provision has not to be made for the passage through the mould of steam and water vapour, as is necessary with green-sand moulds. Dry-sand moulds are more costly than green-sand, and are used when large quantities of metal have to be run into the mould, and exact contour of casting and conformity to the form of the model are necessary. This exactness is possible owing to the mould being made hard and perfectly rigid as a result of the drying. Foundrymen often confound hardness with impermeability to the passage of gases through the mould. There is no necessary connection between hardness and impermeability by gases, and dry-sand and loam moulds are examples of hardness and permeability. In green-sand moulds, hardness and defective permeability by gases go together, as the mould has not only to allow free passage to the carbon monoxide generated by the heat of the molten iron, but has also to allow free passage for large volumes of steam and water vapour.

Loam moulds are employed when it is desired to obtain the desired casting with a minimum of cost for pattern-making. The materials for the mould consist principally of soft red bricks, with loam, a mixture of sharp sand and clay, as the binding material. The loam is used of a similar consistency to that of the mortar used by a builder, and soft bricks are used in preference to hard, as they absorb moisture more readily, and thus admit of faster work being done. The loam also adheres better to soft bricks. As the clay in combination with the sand has lowered the fusion point of the mixture, care has to be taken that the iron does not form a silicate by fusing the mixture of sand and clay at all points of

contact. Fusion of the sand is prevented by interposing betwixt the metal and the sand a coating of carbon. Carbon is absolutely infusible. In the case of green-sand moulds, a quantity of coal dust made from bituminous coal is mixed with the sand. The hydrocarbons generated by the heat of the metal are absorbed by the surface of the casting, and give it the beautiful blue or greyish-blue colour desired in castings of best finish. With the South Staffordshire moulding sand this effect can be obtained without the surface coating of carbon and by means of the coal-dust alone mixed in the sand. This shows that South Staffordshire moulding sand has a high fusing point. I experimented with the object of ascertaining what it was gave castings their particular colour of skin, and proved that the hydrocarbons from bituminous coal-dust gave the results desired in green-sand castings. I prepared two high-polished pieces of iron, and placed each on the top of a small clay crucible, and placed each small crucible in a larger crucible, luting on the lid of the large crucible. In one small crucible was bituminous coal-dust, in the other anthracite coal-dust. The pieces of iron were not in contact with the coal-dust. The crucibles were fired in a muffle for 12 hours, with the result that the piece of iron over the anthracite showed no change; the other piece of iron showed the desired colour characteristics.

The carbon used to face the surface of green-sand moulds is wood charcoal made from one of the heavier woods, such as the oak. In dry-sand and loam moulds no coal-dust is used, and as the moulds are subjected to drying at a high temperature, the use of charcoal for the surface is not permissible. The carbon used for these is that obtained from gas retorts, ofttimes with an admixture of plumbago or "black-lead."

*Moulding Sands.**

| | Mansfield. Per cent. | Erith. Per cent. | South-Staffordshire. Per cent. |
|---|---|---|---|
| Silica ... ... | 94.02 | 87.86 | 93.40 |
| Alumina ... ... | 3.73 | 5.04 | 4.06 |
| Oxide of iron ... | 2.07 | 4.28 | 2.14 |
| Lime ... ... | — | 0.30 | — |
| Loss on ignition | — | 2.41 | — |
| | 99.82 | 99.89 | 99.60 |
| Clayey matter removable by washing | 4.70 | — | 4.80 |

* Buchanan, "Engineering Magazine," Feb., 1903.

*Coal-Dust for Moulds.*
Sample dried at 100° C.

| | Per cent. |
|---|---|
| Sulphur ... ... ... ... ... | 0.973 |
| Ash ... ... ... ... ... | 10.470 |
| Hydrocarbons ... ... ... ... | 33.760 |
| Fixed carbon ... ... ... ... | 54.797 |
| | 100.000 |

Moisture as received 6.05 per cent.

## Melting the Iron.

A few foundries engaged in the production of special castings, such as rolls for rolling mills, use the reverberatory or "air furnace," but probably over 99 per cent. of the castings produced in this country are cast from iron melted in the cupola furnace. In the "air furnace" only one quality of iron may be melted at one time, but with the cupola one may melt three or four qualities during an afternoon. In its simplest form, as seen in many foundries to-day, the cupola is almost exactly the same furnace, so far as general arrangements are concerned, as that in which cast iron was first produced or at least noticed historically about the beginning of the fifteenth century. At that time charcoal was the fuel employed. Now coke is invariably used, the coking of coal being first publicly accomplished about the year 1768 by Abraham Darby, of Coalbrookdale. There is, however, reason to believe that the coking of coal and the successful smelting of iron with it was accomplished by Dudley about the year 1621, but being used as a "secret" process, the secret died with him.

The cupola in its simplest form is a vertical cylinder lined with fire-bricks, has two or more openings for the entrance of the blast, an opening near the top through which the iron, coke, and limestone are charged, and a small hole about 1 in. in diameter at the bottom through which the molten iron is run. The ease with which a competent cupola-man draws off any required quantity of molten iron is remarkable. He can measure out molten iron with as great facility as a milkman measures out milk.

If one examines the interior of a cupola in which iron has been melted a region of greatest wear will be observed. This is known as the "melting zone," and begins about 12 in. above the tuyeres where the blast enters, extends vertically for about 24 in., and there terminates abruptly. This is the region of highest temperature, and it is at the top of the melting zone that the iron changes the solid for the fluid condition and trickles through the coke forming the bed to the hearth of the cupola. In a rapidly melting cupola the molten iron falls just as if it were so much rain. When charging the cupola preparatory to melting, a bed of coke, extending a foot or so above the top of the melting zone, is put in and kindled. Then a layer of iron is put on the bed, then another layer of coke with some limestone added, to flux the ash of the coke and sand adhering to the pig-iron. On this is laid another layer of iron, and so on until the cupola is full

up to the charging door. Melted iron first appears eight or nine minutes after the blast is put on. A regular, steady blast is very important, as it has been observed that blast of varying pressure has a marked effect upon the quality of the iron. High pressure of blast makes the iron harder, and low pressure makes it softer, so that if the iron is mixed to give a certain definite hardness, this may be nullified by a variable blast pressure.

### Mixtures of Iron for the Cupola.

The mixing of iron on scientific principles is of very recent origin, but is being practised more and more by progressive, because better educated, foundrymen. Unfortunately, there exists in this, as in other countries, a large number of men in charge of foundries who, however skilled they may be in the ordinary routine work of a foundry, have not had the training, nor have they the knowledge, of how to apply chemical and metallurgical principles. This, for them, unfortunate position puts them into endless difficulties if they have to leave the beaten track of "use and wont." Where special strength or hardness or softness is required, they have to depend on brands of iron which in the course of years have obtained a reputation for the particular quality desired. They are not aware that the particular qualities of an iron depend upon its chemical constitution, and that no make of pig-iron is always of the same quality. Indeed, some pig-irons which have the same brand as they had 20 years ago are now made from quite different ores. Hematite iron, usually considered by foundrymen as the purest iron they can use, is often worse than ordinary pig-iron in respect of sulphur. These have been rejected by steel makers on that very account, and are passed on to the ironfounder of a larger faith in continuity of quality.

Such things would not be possible were iron foundries generally run on strictly scientific lines, as are all steel works and most blast furnaces. The blast furnacemen themselves buy iron ores and coke, subject to suitable analyses, but most of them have a marked disinclination to sell their iron to analysis. They prefer selling their iron by the well-known system of numbers—1, 2, 3, and so on—but no one has yet defined what any one of these numbers is meant to convey. In the whole domain of metals there is nothing so unscientific as this system of selling and buying pig-iron by numbers. The blast furnacemen have objected that, did they sell to analysis, most foundrymen would not know how to use the iron when they got it. That is perfectly true of many foundrymen at the present time, but were they confronted with the difficulty, of which unfortunately there is no immediate probability, they would perforce have to study the metallurgy of cast iron with the greatest possible resulting benefit to themselves, and to the industry in which they are engaged. At the present time, only the very large firms, whose volume of business must be secured, are enabled to buy to an analysis. Once these firms have used analysis in the purchase and use of their foundry materials, nothing would induce them to revert to old methods of purchase and of use which are haphazard in the extreme. In a word, foundries using scientific methods of work find that they pay handsomely.

Before a foundryman can use scientific methods in his work, it is obvious that he must have some training in, at least, elementary chemistry and metallurgy. I have heard a very successful teacher of metallurgy say recently, that the number of foundrymen attending the classes had increased largely within the last two years. This is a most encouraging fact for those interested in the advance of the industry.

When one begins to apply scientific principles to the mixing of iron in the cupola, a profound knowledge of the metallurgy of cast iron is not necessary. A knowledge of the principles governing combustion, the function of fluxes, such as limestone, to form suitable slags, and the influence of the various constituents of cast iron so far as they affect the general body, will do for a beginning. I have heard it said that a certain noted metallurgist, after making over three thousand tests with iron containing varying proportions of carbon, stated that he did not know anything about the influence of carbon on iron.

In the case of cast iron we have not only carbon to consider, but also silicon, phosphorus, sulphur, and manganese. These may naturally be thought to complicate and render more difficult the study of this metal. Each of the elements named may be helpful to the founder under one set of conditions and hurtful under other conditions. The ironfounder, using scientific principles, uses only those which serve his purpose. Before he can do so he must understand what they are going to do for him, favourably or adversely, when he has in view the production of a particular quality of iron. By doing so, he puts aside all questions of

brands and numbers of pig-irons, and forms his new compound in exactly the same way as the chemist does his. Each deals with elementary substances which combine in certain definite proportions. Beyond this, however, the ironfounder has to consider the changes which take place when melting the iron, and also the influence which size of casting has upon the ultimate product, owing to fast or slow cooling.

Having dealt at some length with the constituents of cast iron and the particular influence which each exerts upon the general body, the author proceeded:—We now proceed to ascertain to what degree they are affected during the melting of the iron. This is necessary to be known before we can predict what the constitution of the iron in the casting will be. To be able to predict what the constitution of the casting will be, and be able to make one's predictions come true, are only possible when using scientific methods in mixing the iron.

When melting iron in the cupola, the constituents are altered as follows, each time the iron is melted, the sulphur in the coke being taken as 0.70 per cent.:—

| | Per cent. |
|---|---|
| Sulphur ... ... ... ... | gains 0.038 |
| Manganese ... ... ... ... | loses 0.100 |
| Silicon... ... ... ... ... | loses 0.250 |
| Phosphorus ... ... ... ... | unchanged. |

Knowing the analysis of the various irons which it is proposed to use in the mixture, adding together each constituent, and adding or subtracting each gain or loss made during melting, one gets wonderfully accurate results. The following mixture for light castings, which will also be strong and soft, shows the method used:—

| Name of Iron used. | Cwts. in charge. | Silicon. | Total Silicon. | Phosphorus | Total Phosphorus. | Sulphur | Total Sulphur | Manganese. | Total Manganese. |
|---|---|---|---|---|---|---|---|---|---|
| Priorfield No. 3 ... | 2 | 3.250 | 6.500 | 1.059 | 2.118 | 0 045 | 0.090 | 0.630 | 1.260 |
| I.X.L. No. 3 ... ... | 2 | 3.079 | 6.158 | 0.321 | 0.642 | 0.035 | 0.070 | 0.250 | 0.500 |
| B.F M. No. 3 ... | 2 | 2 753 | 5.506 | 1.260 | 2.520 | 0.050 | 0.100 | 0.600 | 1.200 |
| Denby No. 3 ... | 1 | 3.033 | 3.033 | 1.549 | 1.549 | 0.019 | 0.019 | 0.337 | 0.337 |
| Scrap ... ... ... | 3 | 2.500 | 7.500 | 1.200 | 3.600 | 0.090 | 0.270 | 0.300 | 0.900 |
| | 10 | ÷ 10 | 28.697 | ÷ 10 | 10.429 | ÷ 10 | 0.549 | ÷ 10 | 4.197 |
| | | deduct | 2 809 .250 | | 1 042 | add | 0.054 0.38 | deduct | 0 419 .100 |
| | | | 2.619 | | | | .092 | | .319 |

The figures 10 used in division are, of course, the number of cwts. in a charge of iron which goes into the cupola.

*Analysis of the castings.*—Silicon 2.619 per cent.; phosphorus 1.042 per cent.; sulphur 0.092 per cent.; manganese 0.319 per cent.

Thermit, Limited, have put into the hands of ironfounders various compounds for use in emergencies, or to obtain very special mixtures of metals. Thermit is a mixture of an oxide of iron-nickel-titanium or other metal, with aluminium in a finely-divided condition. Once combustion begins, an exceedingly high temperature is obtained without other heat than that obtained from the oxidation of the aluminium. The aluminium obtains the oxygen from the metallic oxide with which it is intermixed, and sets free the metal. The aluminium having become oxidised goes into the slag and floats on the top of the pure metal which has been produced. The Thermit process, however, can only have a limited use in iron foundries. If from any cause a large ladle of iron has been allowed to get "dull," that is, has cooled sufficiently to be in a sluggishly fluid condition, then Thermit will be advantageous for the recovery of the necessary fluidity. Or if one desires to obtain special alloys of iron and nickel, or iron with definite percentages of titanium, or other rarer metals, the Thermit process readily provides the means to do so.

A method of making castings in permanent iron moulds without chilling the iron has recently been introduced by Dr. Charles Szekely. The chilling is prevented by coating the iron mould with a compound of which steatite or French chalk is one of the components. The base of the mould is a fixture; two sides are put into and held in position by adjustable screws. The front and back sections are held in position by adjustable studs in the hinged top of the mould. All the meeting surfaces are planed, and vent holes through the iron mould are provided wherever cores require exits for the gases generated when the iron is run into the mould. As is the case with all moulds where there is to be direct contact of solid and liquid iron, the iron mould

gets a preliminary heating. This is really making certain that no moisture is present on the surface of the mould. To bring liquid iron into contact with damp cast iron, or *vice-versâ*, one might as safely play with gunpowder. The moisture which has condensed on a cold iron mould is instantaneously converted into steam by the molten iron, and an explosion results. I have been present when three tons of molten iron were exploded into the air by a similar cause.

The Szekely process of casting requires to be carried on in foundries where melting is continuous throughout the day.

It may be noted that it is quite possible to work ordinary chill moulds so rapidly, that is, fill them with molten iron in such rapid succession, that the iron mould begins to give off gases at a temperature under that of a dull red heat. This results in the castings being spongy, though they were solid when the iron mould was at a lower temperature.

The recording pyrometer is now being used in some foundries engaged in the production of malleable castings. It is used in the annealing ovens for the purpose, not only of recording the temperatures employed, but also to act as a tell-tale as to whether the firing is regular or not. The annealing of malleable castings is still very largely empiric, and not much advanced in knowledge or practice during the hundred years which have elapsed since Lucas patented the process. This result is almost wholly due to the "closeness" with which each malleable founder keeps the details of his operations. The silence which accompanies the manufacture of malleable castings would almost persuade one that the methods are secret, whereas the principles are well known. It is no secret that in no branch of the iron trade is systematised scientific study and experiment more necessary. At present the exponents of the art of malleable casting prefer to remain dumb, and they must therefore be left to welter in a chaos out of which only the scientist can bring order.

This paper would be of inordinate length were I to treat of the use in the foundry of the microscope and of metallography as important adjuncts to analysis, whereby one can watch day by day whether the proper structure of the metal is being obtained, but time does not permit. I am glad to bear testimony to the fact that scientific methods are being more and more adopted in the foundries of this country, and more and more foundrymen are to be found in the metallurgical classes of our technical schools. These two facts, conjoined with the further fact that we have the happiness in this country to possess the most able practical foundry workers to be found on the face of the globe, make one look to the future of this great industry, not only with hope but with confidence.

### Discussion.

Dr. Szekely gave some further information about his process, and illustrated its working by means of one of the moulds described in the paper. He also exhibited a casting made by it.

Mr. S. B. Goslin thought many of the facts the author had mentioned would be of very great service to all who were interested in the daily occupation of founding. His remarks, however, had been confined solely to the use of iron, nothing being said of copper, tin, or zinc. As the author pointed out, the founder of the present day in this and other countries was not much better off than in olden times, because he had to deal with men who, although they might be steady and skilful at the cupola, were entirely devoid of any knowledge of the chemistry of metals, or the reasons why when metals were melted and put into moulds, they frequently produced unsatisfactory castings. It was most encouraging to hear, however, that so many young men, he supposed in the Midland Counties especially, were studying the chemistry and the specific character of the metals with which they had to deal. He had experienced difficulties the author had mentioned as arising from the classification of iron by numbers 1, 2, and 3. When an application was made to the iron master to give an analysis of the iron, he put the founder off with the evasive answer that he did not know anything about it. When he had complained of the No. 3 Carron iron, he had been told to try No. 1, which was satisfactory for one or two pourings, and then was as bad as No. 3. Exactly the same remark applied to other Scotch irons, and Staffordshire and Derby products. As the author had stated, one of the secrets of success in casting iron was that there should be sufficient silicon in the iron, as the French discovered years ago. He was sorry the author did not refer more to the question of fluxes, America being in that respect far in advance of this country, Germany, or France. At the present time he obtained his fluxes from the United States.

Mr. R. H. Read said that unfortunately foundrymen in London could not systematise their work in the way one

might think it could be done from the author's remarks. The author had given the characteristics of different qualities of iron, such as good, bad, hard, and soft, but a special quality was needed for each casting required. It was impossible to generalise in London. There was no pipe foundry in London where nothing but pipes were made, and unfortunately foundries had to meet the requirements of all classes of customers. For instance, he had noticed that afternoon that in his own foundry there were such different articles as a steam cylinder, a builder's column, some ornamental railings, and some brake blocks for motor cars. It was impossible to have different kinds of pig-iron for such a variety of work, and the system his firm had adopted was to use the very best pig-iron even for castings which did not require such a high quality. Nine out of ten customers wanted the iron soft, and by using a pig which insured that requirement complaints were generally avoided. He used the best Scotch pig, and with the particular brand he was now using he had not received a complaint in four or five years. The character of the casting was determined also not only by the pig but by the scrap that was used. In the Midlands, four parts of pig to one part of scrap were generally used, but in London the proportions were practically reversed.

The micro-photographs the author had shown no doubt gave the true determination of the structure of the iron, but he did not think the method altogether did away with the old-fashioned method of believing one's own eyes. By breaking the iron it was possible to tell whether it was hard or soft, whatever number it was called. Naturally it was necessary to use soft scrap as well as soft pig if a soft casting was required, but for such articles as fire cheeks and fire bottoms for big cooking ranges, which, owing to the fierce fires, burnt through very quickly, it was necessary to use the very commonest class of iron which had been burnt before, pig being useless for the purpose.

Mr. Hugh Stannus said the author had referred to a difficulty connected with the escape pipe, which he noticed was not at the highest point of the receptacle. He suggested that if the receptacle had been domed, and the escape pipe had been at the top of the dome, there would be more chance for the heated gases to escape. The paper he thought could be summed up in the phrase that it was necessary to analyse the iron and keep an eye on the cooling. As he was born in Sheffield, and had the honour of sitting under Henry Sorby, one of the most clear-headed men who had ever honoured the British nation, he had been intensely interested in the series of slides shown. Large cutlery works in Sheffield kept their own analyst, because, as the chief partner of Thomas Turner & Company had said to him, they liked to know what went into their knives. It was the application of science to the alloying of the metal which had made the name of Turner in the cutlery world. He thought it might be worth the while of some public chemist in London to conduct similar analyses of metals. Architects at present simply analysed iron by breaking it, treating it with acid, and looking at it with a lens; but it would be possible to find out much more clearly what was in the metal by means of a thorough analytical test, such as was made by Kircaldy. Personally, he had had more to do with the application of art to metal work, but that did not preclude the application of science to the same subject; and he thought the paper would materially conduce to that application.

Mr. F. W. Harbord said he had been particularly struck by the author's statement that, by the aid of the microscope, he was practically able to control his iron. The microscope had been used similarly in regard to steel, but it had not arrived at the same state of perfection. In 99 cases out of 100 the problem of a foundryman consisted in finding a method of maintaining a soft iron, and that could be done by regulating the percentage of silicon in the iron. In most foundries, at all events in the Midlands and the North, it was the practice to use glazed pig-iron, or high silicon pig-iron, and when the brands and the scrap were stronger than usual, to add a larger amount of glazed iron, thus maintaining in the finished product a regular iron containing a percentage of silicon which was found to give the best results from that particular practice. In most cases an iron was required which would give the greatest maximum stress combined with maximum softness, two rather antagonistic requirements, but they could be obtained by adding silicon. In London practice, foundries which used a large quantity of burnt scrap could, by using a comparatively large quantity of high silicon pig, restore it to the required degree of softness. It would be of interest if the author would state whether the high ferro-silicons, which were being used largely in steel foundry practice, were also being used in iron foundry practice.

The Chairman, in moving a hearty vote of thanks to Mr. Buchanan for his ex-

tremely interesting paper, thought a paper on such a subject ought not to be allowed to pass without mention being made of the name of Roberts-Austen, who was connected with the Society for many years, having served for two successive terms as a member of the Council. He was the chemist of the Mint; and no living man in his time did more for the science of metallurgy in the way of rendering it popularly understood. He was a most lovable man, in addition to being one of the ablest and most brilliant intellects that he ever met. He was probably the first to point out the effect of infinitesimal variations in the composition of certain constituents of metals, and also the effect of phosphorus. Roberts-Austen was also the originator of that somewhat memorable address of his (the Chairman's) late partner, Sir Frederick Bramwell, when he was President of the British Association, on "The Next to Nothing," where Sir Frederick pointed out how, in the industrial and scientific world, the next-to-nothing was of infinite importance in the effect it had on the resultant product. When Dr. Szekely's work was first brought to his notice some five or six months ago, he (the Chairman) thought he knew something about casting and cast iron, having from his earliest days been connected with cast iron and other metals; but when he was told by Dr. Szekely's representative that, in an iron mould, he produced in less than a minute a motor car cylinder or a pair of cylinders, and from any ordinary metal which was used in London foundries a casting which could be easily machined, and which was practically without contraction or expansion, *i.e.*, when cooled fitted the mould exactly, he was inclined to laugh. But he had seen that done, not only with motor car cylinders, but with a good many other things. He did not know why it was possible; but it had upset one of the ideas which was firmly secured in his mind as to what it was possible and impossible to do with castings. Aluminium was a much more difficult metal to cast than iron, from the point of view of shrinkage and expansion, and yet Dr. Szekely had informed him that he was able to do the same with aluminium in an iron mould as he did with cast iron. The author had shown a Chinese cupola, and belauded it by saying that more satisfactory metal could be produced from it than any other cupola he knew. If, in his reply, the author gave some slight indication of his reason for that assertion, he thought it would be of interest to the meeting.

The vote of thanks having been carried unanimously,

Mr. Buchanan, in reply, said he was sorry he had led the Chairman to believe that the Chinese cupola was better than any other, because he was simply speaking of cupolas in general, and not of any one in particular. With a cupola of 19 cubic feet capacity from the bottom of the charging door, he had melted more than 1 cwt. of iron per hour per cubic foot. One explanation of the fact was that the larger the cupola the less metal it would melt per cubic foot. In the small cupola the coke was in direct contact with the air, and the combustion was more rapid. By using good coke and a properly proportioned blast, those results might be obtained by anyone who mixed a little brains with his practice. In reply to Mr. Goslin, he did not profess to be an authority on the founding of copper, zinc, and tin, one metal usually being sufficient for one man to specialise in. He also desired to correct Mr. Goslin's statement that the French discovered the influence of silicon on iron; Professor Turner, of Birmingham, being the first to make that discovery. On the general question of the education of foundrymen, he desired to mention that there was a body called the British Foundrymen's Association, of which he had the honour to be the first President. The members of that Association hoped to educate each other so that they would become better foundrymen, and in that way better citizens of this country. There was a patriotic motive at the back of the Association, and it hoped before long to make the foundry industry in this country what it ought to be. Mr. Goslin had also referred to American fluxes. He remembered reading about seven years ago that a smart American was going round the country selling a patent flux, which another smart American discovered was slag from the blast furnace. Fluxes of that kind were not required in this country, but if Mr. Goslin wanted them he could introduce him to people in South Staffordshire who would be glad to let him take them away. The difficulty Mr. Read mentioned of the great variety of castings was undoubtedly an important one, but a man who wanted a soft cylinder evidently did not know what was good for him. Mr. Read had also stated that it was possible to tell by breaking the iron whether it was hard or soft. If a blast furnaceman ran a certain pig-iron out of his furnace, covered it up with sand, and allowed it to cool very slowly, would Mr. Read be able to say what number pig it was? If the blast

furnaceman cooled it quickly with no sand on the top it was called No. 3; if sand was put on the top, and it was allowed to cool slowly it was called No. 1. Reference had been made to Dr. Sorby. He saw some of Dr. Sorby's original sections in the Sheffield University a few months ago, and looked upon them with the greatest possible reverence as the first beginnings of a great advance in metallurgy. In reply to Mr. Harbord, it was impossible to control the iron by means of the microscope, it only being possible to tell by it whether the original structure which ought to be obtained was being maintained, and that could be done with a given section of casting. There was no use, however, changing from a thin section to a thick one, because the same structure would not be obtained; but if castings were being run which were soft and fairly tough, then it was possible to tell whether the iron was keeping regular or not. He knew one foundry which was using high ferro-silicon iron. Close-grained iron, hard and low in silicon, was being run, but when a particularly thin casting was made which had to be machined, some high ferro-silicon iron was put into the ladle, thus softening that particular lot of metal for the casting. He entirely agreed with the Chairman's remarks about Roberts-Austen, whose name was a household word in England. He hoped his paper would stir up foundrymen to be open with what they were doing. If that principle were adopted it would be more helpful than hurtful, because it was only by having confidence in one another and assisting the industry that it would reach the high standard they desired it should attain.

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MESSRS. E. A. SCREEN and A. Screen, engineers, Tipton, have dissolved partnership.

A MEETING of copper and brass manufacturers, engineers, and others, was held in Manchester recently, with Mr. W. H. Johnson (Richard Johnson, Clapham & Morris, Limited, Manchester) in the chair. It was resolved to form a Copper and Brass Institute, with the following objects:—(1) To afford a means of communication between members of the trades in question, bearing upon their respective manufactures, excluding all questions connected with wages and trade regulation. (2) To arrange periodical meetings for the purpose of discussing practical and scientific subjects relating to the manufacture, working-up, and use of the non-ferrous metals.

## THE USE OF THE PHOSPHORISER.*

IN the manufacture of phosphor-bronze or of phosphor-tin, the appliance generally known as the "phosphoriser" is almost exclusively employed for introducing the phosphorus into the molten metal. It has been used for many years and its design has not been altered.

The "phosphoriser" is made of graphite crucible material. It is bell-shaped, and on the sides are holes pointing downward for the escape of the fumes of phosphorus. In Fig. 1 a "phosphoriser" is illustrated. In Fig. 2 a cross-section of it is shown.

FIG. 1.—PLUMBAGO PHOSPHORISER.

The top of the device terminates in a stem through which a hole is made. An iron rod is inserted through this hole and fastened with two nuts. This serves as a handle. The top should be bent at right angles so that the operator who uses the "phosphoriser" can stand at some distance from the furnace. The bottom of the rod with the nut on it is protected by a lump of clay.

*Before using a "phosphoriser" it*

* "Brass World."

*should always be carefully annealed by slowly heating to a red-heat* Unless this is done, and a green "phosphoriser" is inserted in a pot of molten metal, it will fly to pieces. An explosion will, of course, take place. Many injuries have been caused by neglect of this precaution. After the "phosphoriser" has been heated to a red-heat, it is allowed to cool before inserting the phosphorus.

The phosphorus that is used is the yellow variety, and occurs in commerce in the form of sticks. These sticks must

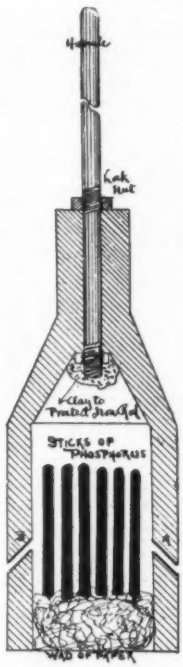


FIG. 2.—CROSS SECTION OF PHOSPHORISER.

be preserved under water or they will ignite spontaneously. *They should never be handled with the naked hands.* Dangerous and painful burns will follow if it is done. Tongs should be used. If the sticks of phosphorus are placed in a strong solution of blue-vitriol in water, in fifteen or twenty minutes, they will become coated with a layer of copper so that they can be handled without danger. The majority of operators, however, do not wait to do this but insert the phosphorus in the "phosphoriser" without any drying, other than to touch it slightly to blotting paper to remove the greater part of the water.

The "phosphoriser" must be *cold* before using in order to prevent the ignition of the phosphorus. A liberal supply of them is therefore necessary in order to render the phosphorising continuous. The sticks are put in the mouth and a wad of paper is inserted to prevent them from falling out. A cover is placed over the crucible holding the metal, that the loss of metal from boiling and splashing may be reduced to as low an amount as possible. The cover has a hole in the middle to allow the entrance of the "phosphoriser."

The use of a small "phosphoriser" is advocated, as the danger and loss of metal are then reduced to a minimum. Beginners should always use a small size. When the sticks of phosphorus have been inserted in the "phosphoriser" and the wad of paper rammed in, the operator takes it by the handle and plunges it down into the metal. A violent ebullition immediately follows. The phosphorus is volatilised, passes up through the metal and burns at the surface. A hood with good draught must be placed over the furnace in order to carry off the fumes. When the action is over, the metal is stirred and the "phosphoriser" removed. The phosphor-bronze or the phosphor-tin, as the case may be, is ready for pouring. The "phosphoriser" should be allowed to become perfectly cold before using.

There is always a considerable loss of metal in making phosphorised alloys in this manner on account of the splashing. A large part of the phosphorus, too, burns. Unless the operator is accustomed to the process, he may lose half of the phosphorus, but with experienced men, from 20 to 30 per cent. only is wasted. This, of course, is on the supposition that phosphor-bronze or phosphor-copper is made. With phosphor-tin the loss is less on account of the lower melting point of the tin.

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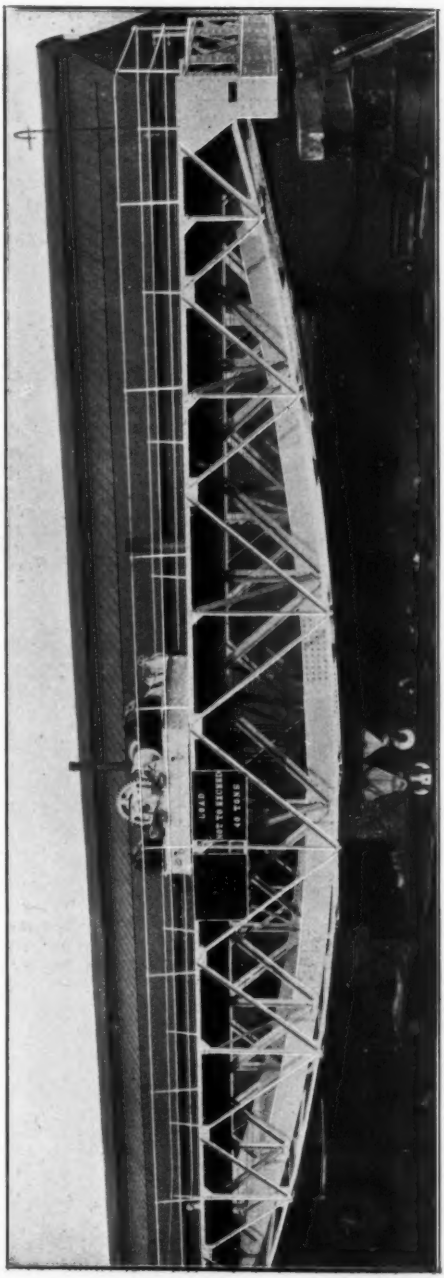
As an interesting and curious fact, we learn from Elders' Navigation Collieries, Limited, that their Welsh foundry coke has for a considerable time been supplied to Glasgow works. As the railway tolls on this coke amount to 18s. per ton alone, the cost delivered must be considerable, and it speaks very much in favour of the care taken by British firms to produce reliable work.

## ELECTRIC OVERHEAD TRAVELLING CRANES FOR STEEL FOUNDRIES.

In the annexed photograph is illustrated a 40-ton overhead crane built by Stothert & Pitt, Limited, Bath, for Messrs. Firth & Sons, Limited, Norfolk Street Steel Foundries, Sheffield. The traveller is of the four-motor type, and takes a load of 40 tons at a span of 82 ft., and clears in a headway of 14 ft. from rail level. The following are the speeds:—

| | Feet per minute. |
|---|---|
| Hoisting, main barrel, 40 tons ... ... | 10 |
| Hoisting, auxiliary barrel, 15 tons ... | 20 |
| Hoisting, auxiliary barrel, 5 tons ... | 40 |
| Traversing, full load ... ... ... | 100 |
| Travelling, full load ... ... ... | 200 |

The main girders are of the lattice braced type. Located at the side under one of the main girders is a substantial cage for the driver, arranged with seat and operating gear. The travelling motion is operated by means of a cross shaft running in gun-metal bearings and driving one wheel in each end carriage by spur gearing. The cross shaft is actuated by a spur wheel and pinion driven by a motor placed at the centre of the span. The crab, which is carried on four double-flanged wheels, has mild steel side frames, the bearings being bushed with gunmetal. The motors for lifting and cross traversing are placed on the crab, which latter has one speed of lifting gear. The load is lifted on eight parts of wire rope, two parts of rope being coiled in right- and left-hand spiral grooves so that the load may be lifted in a true vertical line, the barrel coiling sufficient rope to give the hook a total rise of 27 ft. The crab is fitted with a subsidiary barrel for lifting loads up to 15 tons, and is fitted with a two-speed rope coiled as previously stated, and giving the hook a total rise of 29 ft. A powerful magnetic brake with a mechanical release is operated from the driver's cage, and is of sufficient power to give complete control of the load when lowering, or to hold the same when in position. This brake is fitted to both main and auxiliary lifts. The rope, 3½ in. in circumference, is of extra special flexible quality, and is fitted with snatch block with ball bearing swivelling hook. The gearing is of steel spur wheels with large pinions of cast steel, and small pinions of forged steel. The first reductions run in oil baths. The traveller has a separate motor for each of the motions. The motors are series wound, reversible,



ELECTRIC OVERHEAD CRANE FOR MESSRS. FIRTH & SONS, LTD.

and of the semi-enclosed type suitable for 220 volts. The crane rate powers of the motors are:—

| | | | | |
|---|---|---|---|---|
| Hoisting... ... ... | 40 | b.h.p. at about | 450 | r.p.m. |
| Hoisting auxiliary ... | 30 | ,, ,, | 600 | ,, |
| Traversing ... ... | 13 | ,, ,, | 700 | ,, |
| Travelling ... ... | 45 | ,, ,, | 650 | ,, |

Each motor is controlled by a reversing controller of the metallic type, provided with suitable metallic resistances. Two collectors with the necessary cables convey the current from the shop leads to the switchboard, and the current is conveyed from the switchboard by means of covered wires to the crab, which is fitted with the necessary sliding collectors. The connecting cables are lead covered, and of 600 megohm. quality.

## BRAZING CASTINGS BY "FERROFIX."

Some railways, and also engineering firms, are now using the "Ferrofix" process for repairing castings, which is being exploited by the Ferrofix Brazing Company, of Dock House, Billiter Street, London, E.C. The annexed illustrations show some castings which have been repaired by this process.

The castings are sent to the Ferrofix Company and brazed at their works. The run of work is very varied, and embraces such vastly different castings as motor car engine cylinders and shear arms. Cast iron can be brazed to itself or to other metals.

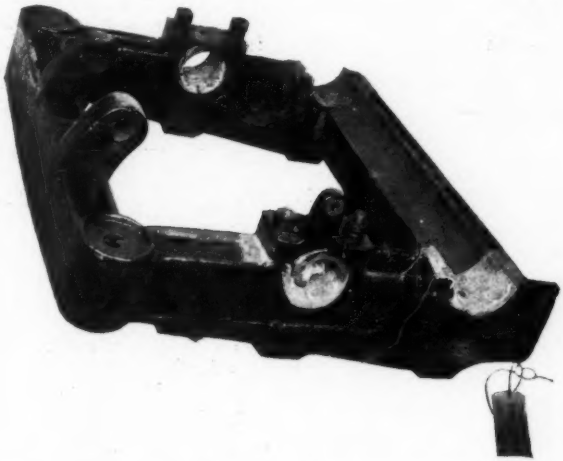


Fig. 1.—Complete Fracture as shown in Cut, restored by Ferrofix. Westinghouse Motor Frame.

Fig. 2.—Shear Arm; Weight, 5,500 lbs., Length, 9 ft., Break, 22 in. by 5 in., Brazed with Ferrofix.

Foundries find in Ferrofix brazing one solution of all the costly problems resulting from shrinkage, cracks, sand, and blow-holes and faulty pouring. Any kind of defect, or mishaps to a casting, can be made good.

Amongst the firms using this process are:—Messrs. Crossley Bros., of Manchester; Belliss & Morcom, Limited, of Birmingham; Musgrave & Sons, of Bolton; and the Great Western and North-Eastern Railway Companies.

—o—

## QUERIES.

*To the Editor of the* FOUNDRY TRADE JOURNAL.

SIR,—Referring to the letter signed "Piston" in your February issue, in

FIG. 3.—MOTOR CAR CYLINDER.

which the writer states his difficulty with gas-engine pistons, I would suggest to him that the trouble is probably due to damp sand, *i.e.*, the castings being so thin and light, the steam and gases generated when pouring do not get away properly and leave a blown or spongy place where they have lodged.

If "Piston" will try making the castings in dry sand, and see to it that the pig and scrap he uses is of good quality and clean (especially free from rust), also that it is melted at a high temperature, I am confident his difficulty will be overcome. Regarding his question as to whether they can be made expeditiously on a moulding machine, I should say yes! Why not? I know it is not common practice to make dry-sand work on the machine, but there is no reason why it should not be done.

He could have the machine fixed close to the drying stove, and lift the moulds direct from the machine on to the stove carriage. After the first day, he would be a day beforehand with his moulds, the carriage could be emptied first thing next morning by labourers, leaving room for that day's moulds. Regarding the type of machine to use, there are so many different makes on the market it is difficult to single out any particular one, but it should be a stripping-plate machine.

Yours, etc.,

R. CARRICK.

*To the Editor of the* FOUNDRY TRADE JOURNAL.

SIR,—We notice an enquiry on page 89 of your current issue to the following effect:—"Lycopodium.—Could you, or any of your readers, tell me of an English maker of lycopodium, or a good substitute?" If you will put the writer in communication with us, we can furnish him with lycopodium, or a perfect substitute for it.

Yours, etc.,

J. W. JACKMAN & COMPANY, LIMITED.

—o—

*To the Editor of the* FOUNDRY TRADE JOURNAL.

SIR,—I was disappointed to find that Mr. C. E. Allen's reply in this month's JOURNAL again fails to meet my question, viz., "How to Reduce to the Fluid State Fine Turnings of an Alloy Containing Zinc, Aluminium, and Iron."

Nearly the whole of his reply deals with the melting and mixing of alloys of aluminium with other metals, and the methods to be followed. I am, however, fairly well posted in all the ordinary methods of melting and mixing these alloys, and have had considerable experience in working them. I am making this alloy, and we are turning out large quantities of castings of it. My only trouble is just this: I cannot at present remelt the fine turnings from these castings, whether heated in a plumbago crucible or in an iron ladle, with or without flux. The whole mass oxidises as soon as a low, red heat is reached, and is entirely fused if the heat is raised; also if the turnings are worked into some already fluid metal the same action takes place, with the further result that some of the good

metal is lost in the process. Hoping that some other reader may be able to advise on the subject.

Yours, etc.,
"A READER FROM THE BEGINNING."

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## CONVERTING BOILER FLUE INTO CUPOLA.

*To the Editor of the* FOUNDRY TRADE JOURNAL.

SIR,—We have a boiler flue 38 in. interior diameter by 20 ft. long, parallel for 12 ft. 6 in., and then tapering to 30 in. diameter at top. We wish to convert it into a cupola, and would be obliged if some of your readers would give us particulars of the best way to do it. There are angle-iron rings every 30 in. We would specially like to know thickness and style of lining, size of fan or blowers, pressure, air belt or not, size and number of tuyeres, and height of charging door. It is for jobbing work from under 1 lb. to a ton in weight, and would not have a receiver.

Yours, etc.,
"FLUE."

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*To the Editor of the* FOUNDRY TRADE JOURNAL.

SIR,—I should be pleased if you could let me know at your earliest convenience where I could dispose of aluminium skimmings, or the best method of treating same.

Yours, etc.,
F. GALLIMORE.

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THE HYDRAULIC ENGINEERING COMPANY, LIMITED, of Chester, have secured a contract from the London and North-Western Railway Company for the hydraulic capstan equipment needed for the Garston Docks.

MR. T. M. EASTHAM, 38 and 39, Trevelyan Buildings, Corporation Street, Manchester, has been appointed Lancashire representative for Messrs. W. Tudhope & Son, Crown Iron Works, Coatbridge, N.B.

MESSRS. NURSEY & MARR, mechanical engineers, etc., 53, Victoria Street, S.W., have established a merchant and engineering business with the Far East, their representatives being at Shanghai, Tientsin, and Vladivostock.

## LIST OF NEW INVENTIONS.

Specially compiled for the FOUNDRY TRADE JOURNAL by MR. GEORGE BARKER, Fellow of the Chartered Institute of Patent Agents, Consulting Engineer and Chartered Patent Agent, 77, Colmore Row, BIRMINGHAM.

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913. K. BIRKELAND. Improvements in the metallurgical treatment of smelting of ores and other materials.

1,110. F. G. Y. BUENDIA. New chemical and mechanical process of treating ores containing carbonate of lime.

1,477. E. W. LEES. Improvements in the casting and fluid pressing of taper or conical steel ingots.

1,710. ALLGEMEINE ELEKTRICITATS GES. Improvements relating to vacuum pumps and compressors.

1,711. W. J. EVANS. Improvements in holders of slabs, cores, and the like, particularly for use in moulding operations.

3,413. R. CREMER. Improvements in the construction of plugs for foundry ladles.

520. C. LEAN, B.Sc. 1907.

This invention relates to improvements in processes and means for manufacturing steel castings, and its object is to reduce the cost of removing the feeding heads. The essential feature of the invention is a means for keeping the necks or bases of the heads in a molten condition until after the feeding has been completed. This is done by passing a powerful electric current in at one of the feeding heads and out at another, the current being preferably provided by a transformer of the welding type.

These feeding heads may be located as usual, but their base portions or necks may be of a smaller size than would be the case if an electric current were not employed to heat them. Preferably the necks are so reduced in size that they can be knocked off with a blow from a hammer, and the strength of the current chiefly depends on the size of the neck and is powerful enough to keep the neck in a molten condition until all the parts to be fed by the head in question are completed.

The heads may be removed in any convenient manner. The heads may be conveniently arranged in pairs, the neck of the one being separated from that of the other by the narrowest partition of moulding composition possible, so that the

necks may require less current to maintain their temperature than would otherwise be the case.

The currents may be conveniently supplied by welding transformers, the secondary circuit of which is provided with steel or carbon electrodes for dipping into the heads or other parts of the castings.

The currents may, however, be led in and out in any suitable manner, electrodes being inserted in the mould walls at suitable parts if desired.

The current may be varied during the cooling of the casting as desired, and after they have solidified may, in some cases, be increased to such an extent as to remelt the necks of the heads to enable the heads to be readily severed from the casting.

—o—

## ELECTRIC WELDING.

In a recent issue of the "Electric Club Journal" (Pittsburg), Mr. C. B. Auel describes a method of using the electric arc for welding and repairing defective ironwork. The author first divides methods of welding into four classes: The Zerener, in which an arc is drawn between two carbon electrodes and caused to impinge on the metal to be welded by means of an electro-magnet; the La Grange-Hoho, otherwise known as the "water-pail forces"; the Thomson, or incandescent process, in which heavy alternating currents are passed through the joint to be welded; and the Bernardos process, in which an arc is drawn directly between the metal to be welded and a carbon electrode.

This latter process is simple and suitable for many uses, and does not require an elaborate equipment. Its application to shop methods is described somewhat in detail. The outfit needed is a controlling rheostat, which may be of the grid type, or two water rheostats improvised from barrels, a carbon electrode, fireclay or carbon blocks for moulding purposes, and a source of supply which can furnish from 75 kw. to 100 kw., at from 100 volts to 125 volts. The operator should have a canvas hood with a coloured-glass window for covering the head and protecting the eyes, and should wear gloves with gauntlets to cover the wrist. A higher voltage than 125 may be utilised, but this is wasteful. A portable generating set consisting of a motor-driven generator with suitable output provided with a controlling switchboard, is convenient. The water rheostat may be formed of two water-tight barrels placed side by side, into each of which dips a triangular electrode of steel plate about $\frac{1}{4}$ in. thick, suspended by means of pulleys and counterweights. The barrels are joined in parallel in the arc circuit. Two discarded castings, weighing about 30 lbs. each, may be used for the bottom electrodes in the rheostats. The carbon arc electrode is held in a clamp attached to an insulated handle provided with a shield to protect the hand. A hard, solid carbon about $1\frac{1}{2}$ in. diameter and 6 in. to 12 in. long is suitable. When used it should wear away to a round stub end, and not to a long point.

For repairing steel castings an iron rod about $\frac{3}{8}$ in. diameter is used. For filling, Norway iron is preferable, though scraps of boiler plant or steel castings may be used. To make a weld the positive terminal of the circuit is clamped to the casting to be welded, so that the current will flow from the metal to the carbon. The carbon is then placed in contact with the metal and drawn away so as to strike an arc about 2 in. long or more. The arc is allowed to play upon the casting until the metal commences to boil. The electrode should be manipulated so as to heat the casting thoroughly within the immediate vicinity of the proposed welding. This will prevent too rapid cooling of the molten metal. When the metal is boiling, one end of an iron rod is placed into it and is allowed gradually to melt away until the opening is filled. The operation should be carried out continually to avoid the formation of slag. When, instead of filling the cavity, it is necessary to build up, a mould is formed of fireclay or blocks of carbon; or motor brushes may be used for this purpose. The process just described is then carried out. If the work is done properly, the weld has a tensile strength, about 75 per cent. of that of the original stock. Data taken from a typical weld show that a hole $1\frac{1}{4}$ in. diameter by 2 in. deep was filled in 56 seconds, the voltage across the arc varying from 63 to 50, the current varying from 550 amps. to 650 amps.

—o—

The gas department of the business of Bruce, Peebles & Company, Limited, has been transferred to a private company under the style of Peebles & Company, Limited, Tay Works, Bonnington, Edinburgh.

## TRADE TALK.

BEYER, PEACOCK & COMPANY, LIMITED, are establishing new locomotive works near the city of Montreal.

MESSRS. T. W. RICE and H. P. S. WISE, engineers, etc., Blackburn, Lancashire, have dissolved partnership.

THE shareholders of Bruce, Peebles & Company, Limited, Edinburgh, have decided to wind up the company voluntarily.

THE NORTH BRITISH LOCOMOTIVE COMPANY have received an order to build sixty locomotives for the Chilian State Railways.

THE adjudication of Mr. Thomas Till, ironfounder, of Hanley, Staffs., has been annulled and the receiving order rescinded.

THE CANNON IRON FOUNDRIES, LIMITED, of Deepfields, near Bilston, have established a branch at 18, Holborn Viaduct, London, E.C.

CONSIDERABLE damage was done recently by a fire in the Blackness Foundry, Dundee. The work of the foundry, however, was not affected.

THE plant of the Pyle and Blaina Works, Limited, Blaina, Mon., has been closed down, owing, it is stated, to depression in trade.

A RECEIVING order has been made in connection with the affairs of Messrs. F. J. Whitworth and E. E. Arnall, engineers, Birmingham.

A DESTRUCTIVE fire occurred at Huddersfield recently, which gutted the extensive works of Messrs. W. C. Holmes & Company, ironfounders.

MESSRS. G. TŒNNIES & COMPANY, 57, Gracechurch Street, London, E.C., have been appointed British agents for Charles Zunz, Limited, Brussels.

MR. A. PALMER, Union Engineering Works, Sheffield, has been appointed Sheffield and district agent for Fielding & Platt, Limited, Gloucester.

MESSRS. CHARLES HENDERSON & COMPANY, of Glasgow, have been appointed sole agents for Scotland for J. Wilkes, Sons & Mapplebeck, Limited.

MESSRS. TAYLOR, LAW & COMPANY, of the Anchor Works, Birmingham, have appointed Mr. A. J. Forsyth as their British Columbian representative.

MESSRS. H. FOWKES & COMPANY, of the Wellington Foundry, Derby, have appointed Mr. H. S. Gibbs, 130, Fleet Street, E.C., as their London agent.

NEGOTIATIONS are proceeding with a view to the amalgamation of the North Central Wagon Company, Limited, with the British Wagon Company, Limited.

A DISSOLUTION of partnership is notified in connection with Messrs. E. G. Gosset-Tanner and R. T. Deane, consulting engineers, Victoria Street, Westminster, S.W.

MESSRS. H. BESSEMER & COMPANY have just had plans passed for extensions at their Bolton Iron and Steel Works, which they took over and restarted a little while ago.

MESSRS. BUTTER BROTHERS & COMPANY, engineers and crane makers, Glasgow, have just received an order for four large derrick cranes and one overhead travelling crane.

BROWNLIE & MURRAY, LIMITED, engineers, of Glasgow, have appointed Messrs. Hatherley Brothers, 110, Fenchurch Street, London, E.C., as their sole London agents.

THE discharge from bankruptcy of Mr. T. Duncan, who had traded as the Abbey Iron Company, Southwark Bridge Road, London, S.E., has been suspended for three years.

MESSRS. GEORGE SCHULTZ & COMPANY, engineers, iron and steel manufacturers' agents, and merchants, have removed to larger and more convenient offices, at 10, Bush Lane, E.C.

PARTICULARS were published during the month of an issue of £1,000,000 5 per cent. third mortgage debentures, in 10,000 debentures of £100 each, of Vickers, Sons & Maxim, Limited.

THE NORTH BRITISH LOCOMOTIVE COMPANY, LIMITED, are having new premises built at Springburn, in which all the clerical work of this extensive concern will be concentrated.

THE creditors of the Reliance Brass and Iron Foundry Company, Limited, are required to send particulars of their claims to Mr. G. H. Tyler, Newton Chambers, 43, Cannon Street, Birmingham.

THE business of Cundall, Sons & Company, Limited, Airedale Iron Works, Shipley, is being voluntarily wound up. Mr. W. M. Gray, chartered accountant, Bradford, has been appointed liquidator.

MESSRS. W. SHAW & COMPANY, Wellington Cast Steel Foundry, Middlesbrough, have arranged with Mr. T. F. W. Dixon, their Lancashire and Cheshire representative, to take over the Birmingham district also, and have appointed Mr. W. H. Atherton, of Warrington, to assist him. The office for the combined districts will be at 12, Exchange Street, Manchester.

## NEW COMPANIES.

LONDON REFINING AND METALLURGICAL WORKS, LIMITED.—Capital £2,000. Registered office: 32, Clerkenwell Road, E.C.

ROCHESTERS, LIMITED.—Capital £5,000, to carry on the business of engineers, and to adopt an agreement with D. N. Jones.

LEE'S ENGINEERING COMPANY, LIMITED.—Capital £1,000, to acquire the business carried on by J. Lee, at Oswestry. Registered office: Station Road, Oswestry.

BUMSTEAD & CHANDLER, LIMITED.—Capital £25,000, to take over the business of engineers, etc., carried on at Hednesford by Bumstead & Chandler.

EDWARD & WILLIAM LUCAS, LIMITED.—Capital £40,000, to acquire the business of Mr. W. Lucas, Dronfield Forge and Shovel Works, Dronfield, near Sheffield.

WILLIAM SUDWORTH & COMPANY, LIMITED.—Capital £2,000, to take over the business of engineers carried on at Nottingham, as William Sudworth & Company.

PHELON & MOORE, LIMITED.—Capital £3,000, to take over the business of mechanical engineers, carried on by Messrs. J. C. Phelon and R. Moore, at Cleckheaton.

PASLEY ENGINE COMPANY, LIMITED.—Capital £6,000, to take over the business carried on by W. H. Pasley, at Sherborne. Registered office: Castleton Engine Works, Sherborne, Dorset.

ANDREW'S ENGINEERING COMPANY, LIMITED.—Capital £2,000, to adopt an agreement with C. H. Andrew and H. E. B. Andrew. Registered office: 45, Waterloo Road, Stockport.

D. WILKINSON & COMPANY, LIMITED.—Capital £1,000, to take over the business of an iron and brass founder, etc., carried on at John Street Foundry, Cardiff, by A. Akenhead. Registered office: 10, Bank Buildings, St. Mary Street, Cardiff.

JAMES SLATER & COMPANY (ENGINEERS), LIMITED.—Capital £50,000, to adopt an agreement with M. Brophy, Holborn Engineering Works, High Holborn, W.C., and to carry on the business of iron-founders, etc. Registered office: 251, High Holborn, W.C.

CATTELANI BROTHERS & COMPANY (1908), LIMITED.—Capital £80,000, to carry on the business of iron, brass, and metal founders, etc., and, if deemed necessary, to acquire the business carried on as Cattelani Brothers & Company, at 5, Lloyd's Avenue, E.C.

## DEATHS.

MR. R. SPENCER, iron founder, etc., of Walton, Liverpool.

MR. J. T. ETCHELLS, iron founder, etc., of Turnock Street, Macclesfield.

MR. J. L. BLACK, managing director of the Southampton Dock Engineering Company, Limited.

MR. J. STEWART who at one time managed the Phœnix Iron Works, Glasgow, aged 76 years.

MR. MARTIN PERKS, a member of the firm of Messrs. F. & J. Hall, Limited, ironfounders, Worcester.

MR. F. TAYLOR, of Messrs. A. E. Taylor & Company, engineers, Market Square, Biggleswade, aged 67 years.

MR. W. MELROSE, a partner in the firm of Messrs. James Melrose & Sons, engineers, Hawick, on February 5 last.

MR. THOMAS STACEY, managing director of Messrs. Warran, Stacey & Company, ironfounders, Swadlincote, Derbyshire.

MR. ALFRED BALDWIN, M.P., chairman of the Great Western Railway Company, and of Baldwins, Limited, aged 67 years.

MR. JAMES HOWDEN, junr., a director of James Howden & Company, Limited, engineers, of Glasgow, at the age of 25 years.

MR. T. PICKARD, chairman for many years of the Birmingham Railway Carriage and Wagon Company, Limited, aged 90 years.

MR. W. WILLOUGHBY, a director of Willoughby Brothers, Limited, engineers, shipbuilders, boilermakers, etc., of Plymouth.

MR. W. K. BIRKINSHAW, a member of the firm of Messrs. W. G. Birkinshaw & Company, edge-tool manufacturers, of the Reliance Works, Wolverhampton.

MR. E. MUIR, the fifth and youngest son of the late Mr. William Muir, of the firm of Messrs. William Muir & Company, tool-makers, Britannia Works, Manchester, aged 65 years.

MR. P. F. HOOLE, of the firm of Henry E. Hoole & Company, Limited, stovegrate manufacturers, at his residence, The Horbury, Grenoside, near Sheffield. He was 61 years of age.

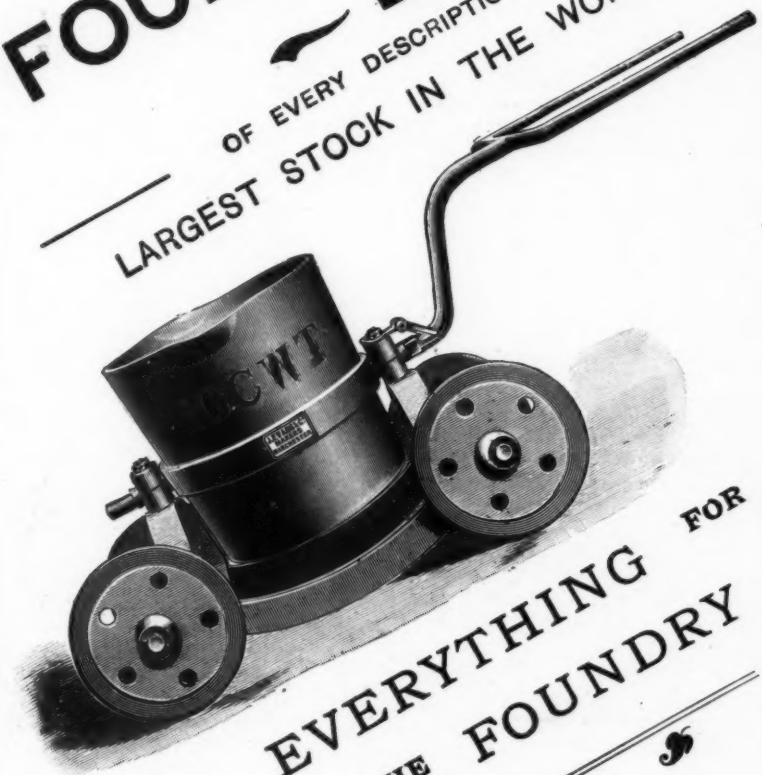
MR. ARCHIBALD BUCHANAN, who had been works manager for Messrs. Vickers, Sons & Maxim, at Barrow, but latterly owned a ship-repairing shop at Barrow for a small private company, at the age of 70 years.

Contractors to H.M. Government.

# FOUNDRY LADLES

OF EVERY DESCRIPTION.

LARGEST STOCK IN THE WORLD.




EVERYTHING FOR THE FOUNDRY

## JAMES EVANS & CO.,

Telegrams:
"LADLES, MANCHESTER."
"BLACKINGS, GLASGOW."

BRITANNIA WORKS, MANCHESTER.

## PERSONAL.

Sir Thomas Wrightson is at present in Cairo.

Sir John Gavey has been appointed Consulting Engineer to the Post Office.

Sir Christopher Furness, M.P., has left London for abroad, for the benefit of his health.

Mr. D. Jackson has been admitted into partnership with Messrs. Denny & Company, of Dumbarton.

Lord Armstrong has resigned his seat on the board of Sir W. G. Armstrong, Whitworth & Company, Limited.

The late Mr. W. Hornsby, a director of Hornsby & Sons, Limited, of Grantham, left estate valued at £234,833.

The gross value of the estate of the late Mr. L. Baxendale, head of the Manchester firm of Baxendale & Company, ironfounders, is £82,974.

Mr. J. T. Goodwin, recently works manager for Cochrane & Company, Limited, Middlesbrough, has been appointed foundry manager at the Sheepbridge Coal and Iron Company's Works. He was recently the recipient of a presentation from the officials of Cochrane & Company, Limited, on the occasion of his marriage.

Mr. R. J. N. Willcox, general manager of the business of Messrs. Fleming & Ferguson, shipbuilders, Paisley, has been appointed marine engineering superintendent to the Thames Conservancy Board.

Mr. A. D. Wedgwood, of the Dennystown Forge Company, has been elected managing director of Cammell, Laird & Company, Limited. Mr. H. E. Deadman, C.B., of the Admiralty, and Major Arthur Handley, have been elected directors.

Dr. Henry T. Bovey, Dean of the Faculty of Applied Science and Professor of Civil Engineering at McGill University, Montreal, has been appointed by the Governing Body of the Imperial College of Science and Technology as Rector of the Imperial College.

Mr. E. Carlisle, general manager of Cammell Laird & Company's Derwent Iron and Steel Works, and Lowther Iron Works, Workington, has resigned his position, and has been succeeded by Mr. Stanley Martin, manager of the firm's iron and steel works at Penistone.

Engineer Vice-Admiral H. J. Oram, C.B., has been nominated by the Admiralty as a member of the Sectional Committee of the Engineering Standards Committee on Sections and Tests for Materials used in the Construction of Ships and their Machinery, to fill the vacancy caused by the retirement of Engineer Vice-Admiral Sir John Durston, K.C.B.

At a recent meeting of the Board of Management, of the British Iron Trade Association, under the presidency of Mr. Alex. Findlay, M.P., Mr. J. Stephen Jeans resigned the position of secretary, and after much expression of regret, the following resolution was unanimously passed: "That this Board accept with very great regret the resignation of J. Stephen Jeans, Esq., as secretary, on the ground of ill-health, and return to him their best thanks for his distinguished and efficient services after a period of over thirty years, during which time his invaluable stores of statistical knowledge and general experience have been placed at the disposal of this Association and the iron trade generally." Mr. Jeans has been, and is still, spending the winter largely in Cannes, where he is making progress towards recovery.

**Ganister, Cupola Blocks, Fire Bricks,**
**Fire Clay.**
***Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.***
**Steel Moulders' Composition, Silica Cement.**

**J. GRAYSON LOWOOD & Co., Ltd.,**
**DEEPCAR, nr. SHEFFIELD.**
Telegrams: "LOWOOD, DEEPCAR."

PATENT

ALUMINO THERMIT WELDING

THERMIC PROCESS

REG. TRADE MARK.

— FOR —

# BROKEN CASTINGS.

# REPAIR SHOP

**NOW OPEN.**

**ESTIMATES for WORK and ILLUSTRATED PAMPHLET upon application to**

# THERMIT LIMITED,

27. MARTIN'S LANE, CANNON STREET, E.C.

# ELDERS FOUNDRY COKE

**As supplied to the British . . Admiralty Dockyards.**

**The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.**

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.

We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blow-holes and other defects, than we formerly did.

From MOUNTFORT PHILLIPS & Co., Llantrissant.

Llantrissant. October 25th, 1904.

In reference to the Foundry Coke you have been supplying us with for the last six months, we have very great pleasure in letting you know that it has given every satisfaction, and that our Works Manager and Workmen give it the highest praise.

## Elders Navigation Collieries, LTD. Cardiff.

## PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years :—

| Metals. | 1907-8. | 1906-7. |
|---|---|---|
| Iron—Scotch pig warrants ... ton | *56/6 | *61/6 |
| —Middlesbro' warrants ... ... ton | 50/5 | 54/11½ |
| —W.C. M/nos Bessemer ... ... ton | 59/0 | 80/0 |
| —Stock, Scotch, Feb. 27 ... tons | 1,028 | 5,024 |
| Copper—Chili bars, GMB ... ... ton | £58 0/0 | £108 7/6 |
| —Stock, Europe & afloat... ... tons | — | — |
| Tin—English ingots ton | £131 10/0 | £194 10/0 |
| —Straits ... ton | £128 7/6 | £191 15/0 |
| —Stock, Ldn. Hind and afloat ... tons | 15,247 | 13,186 |
| Lead—English pig ton | £14 2/6 | £19 17/6 |
| Spelter—Ord. Silesian ... ... ton | £21 5/0 | £26 2/6 |
| Quicksilver (75lb.) bottle | £8 4/6 | £7 0/0 |
| Antimony—Regulus ... ... ton | £35 0/0 | £104 0/0 |

*Settlement price.

### Castings.

In the Cleveland district the following are the nominal rates current for castings :—

| | £ s. d. | | £ s. d. |
|---|---|---|---|
| Columns (plain) ... ... | 6 15 0 | to | 7 0 0 |
| Pipes, 1½ to 2½ in. ... ... | 5 2 6 | to | 5 7 6 |
| „ 3 to 4 in. ... ... | 4 15 0 | to | 5 5 0 |
| „ 5 to 8 in. ... ... | 4 12 6 | to | 4 15 0 |
| „ 10 to 16 in. ... ... | 4 12 6 | to | 4 15 0 |
| „ 18 to 24 in.... ... | 4 12 6 | to | 4 15 0 |
| Chairs ... ... ... ... | 3 12 6 | to | 3 15 0 |
| Floor plates (open sand) ... ... ... ... | 3 0 0 | to | 3 2 6 |

### Scrap.

The quotations for scrap, subject to market fluctuations, are as follows:—Heavy wrought (mixed), £2 6s. 0d.; light wrought, £1 1s. 0d.; heavy cast, £2 7s. 6d.; all per ton f.o.b., London. Copper (clean), £53 0s. 0d.; brass (clean), £40 10s. 0d.; lead (usual draft), £13 5s. 0d.; tea lead, £11 10s. 0d.; zinc, £17 0s. 0d.; all per ton delivered merchant's yard.

SILICA FIRE BRICK Co.,

OUGHTIBRIDGE.

GROUND GANISTER,

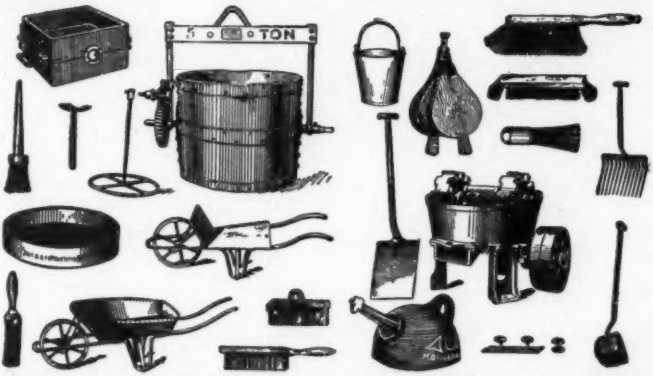
Wet or Dry.

Silco Cupola Bricks, 90 % Silica.

*Better than Fire-clay Bricks for Cupolas.*

*Established 1863.*

# Jas. Durrans & Sons,



PHŒNIX WORKS, PENISTONE, Near Sheffield.

Manufacturers of all

## FOUNDRY EQUIPMENTS,

**Composition Black Lead,**

**Plumbago, Core Gum, White Dust, and Coal Dust.**

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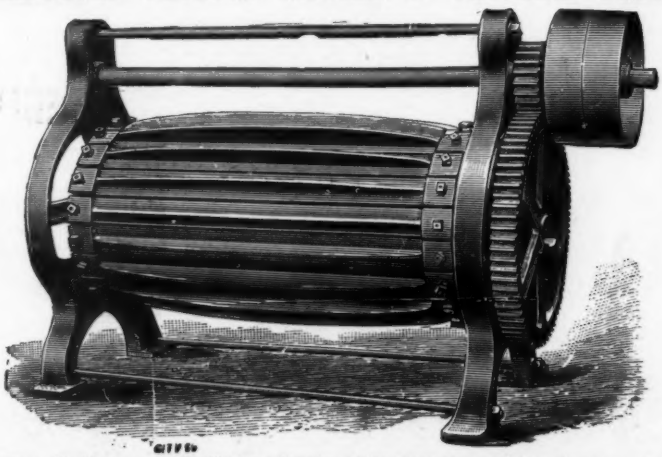

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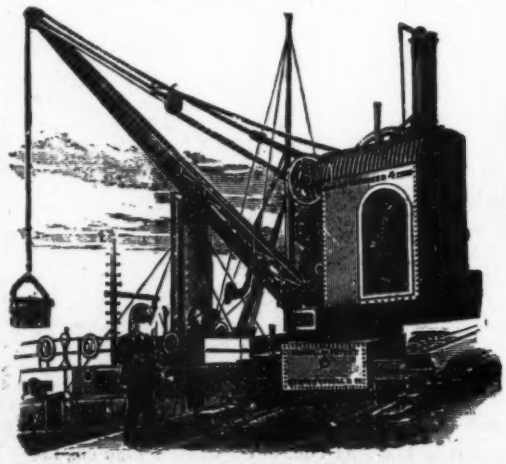

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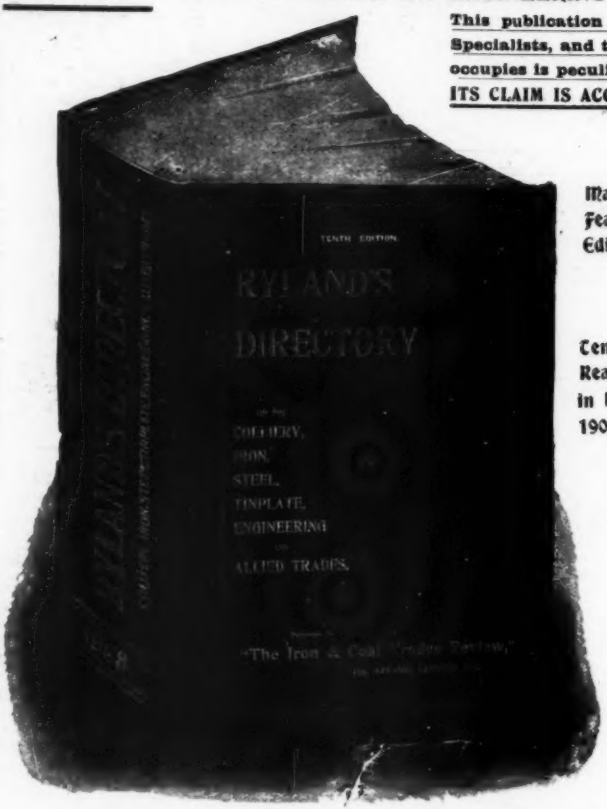


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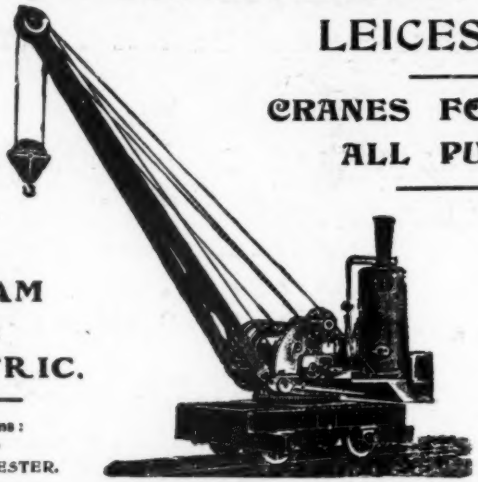

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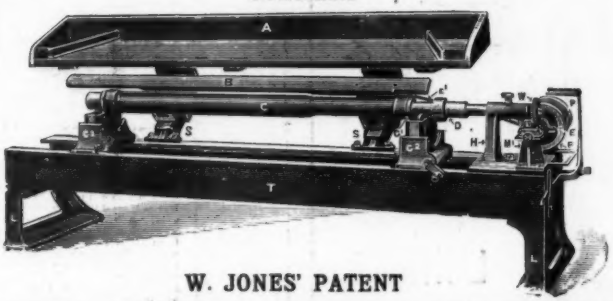

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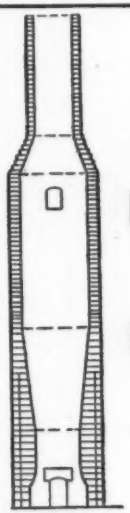

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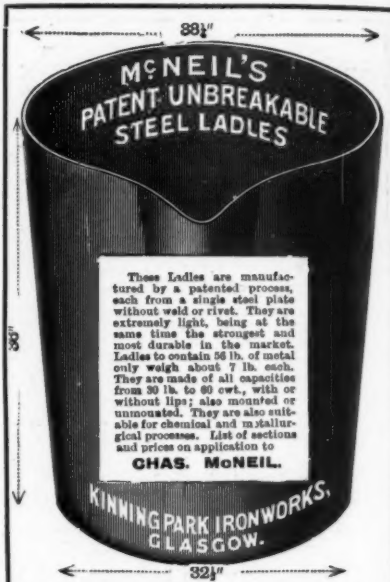
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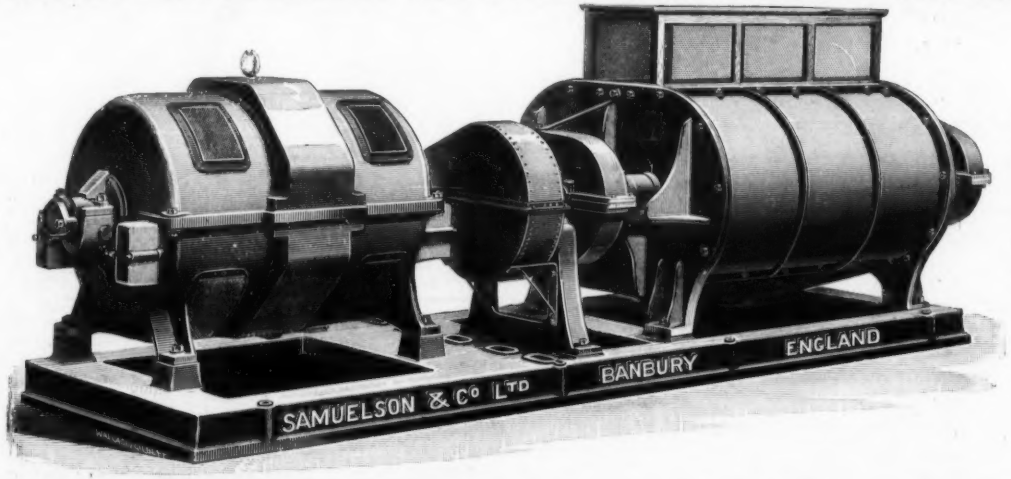


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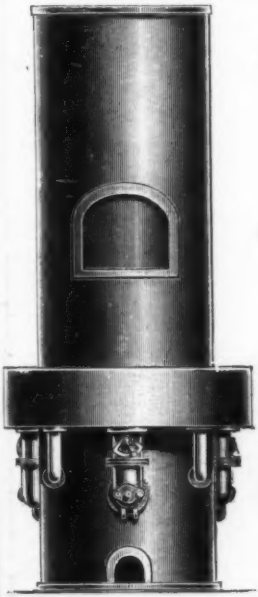

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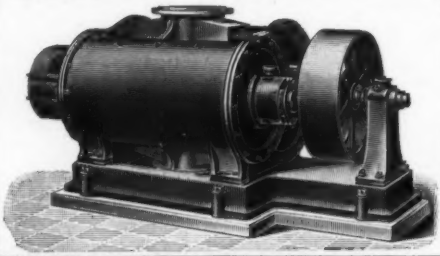

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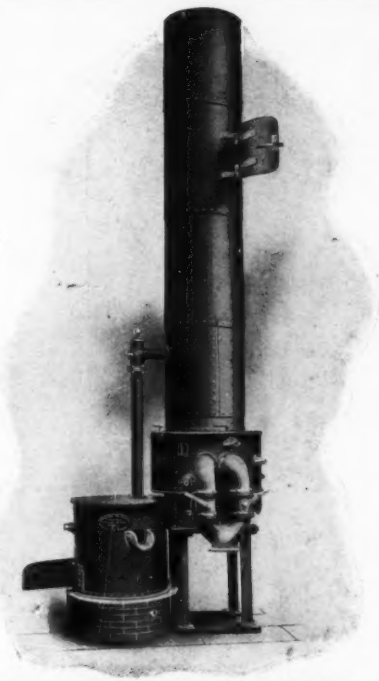

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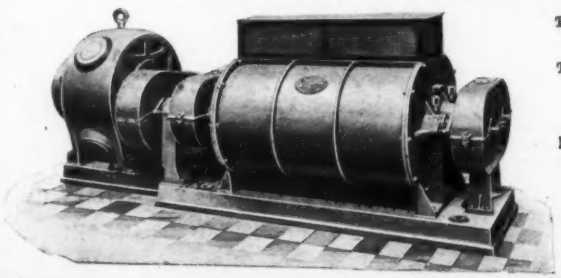

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